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The Decision Template Concept

Clinton W. Kelly, III
Roy M. Gulick
Richard R. Stewart

DECISIONS and DESIGNS, INC.

Prepared for
Command and Control Technical Center
Defense Communications Agency
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THE DECISION TEMPLATE CONCEPT

by

Clinton W. Kelly, III, Roy M. Gulick, and Richard R. Stewart

Prepared for

Command and Control Technical Center
Defense Communications Agency
Washington, D.C. 20301

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The purpose of this research ~~report~~ was to demonstrate and evaluate the use of computer-based decision templates in a National Military Command Center-like environment. Decision templates are prestructured procedural aids for evaluating various alternative courses of action available to a decision maker. The computer-based decision aids described in this report were structured using decision analytic methodology. Prototypes of these aids were designed,

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implemented, and tested under the sponsorship of the Defense Advanced Research Projects Agency (DARPA) between 1976-1978 at the headquarters of the U.S. European Command.

The objectives ~~of this research program~~ were to redesign and improve the prototype decision aids; to evaluate the improved aids; and to study the possibility of incorporating decision templates in military command and control systems. Two new decision template aids were designed: OPSEL (option selection) and R-Screen (rapid screening of options). R-SCREEN was designed to support those situations wherein less than two hours is available for reaching a decision, and the user has virtually no technical familiarity with decision analysis. The OPSEL aid supports those situations wherein two to four hours are available, and the user has substantial technical expertise in decision analysis. Another aid, SELECT (information selection) permits the user to create a data base and to retrieve information from it.

Fulfillment of the final objective of this project involved two activities: first, conducting several real-world decision analyses with the participation of the contract sponsor, the Defense Communication Agency (DCA), and second, investigating the current crisis action system used by the JCS. These analyses addressed such problems as site selection, test-bed location, selecting a research and development investment strategy, and evaluating requirements for automated data processing support of crisis action functions.

This report concludes that decision templating methodology provides the means to meet DCA's goal of improving the communication and processing of information and the quality of national security decision making in crisis action situations.

SUMMARY

Background

The purpose of the research program described herein was to demonstrate and evaluate, through controlled environment experiments, the use of computer-based decision templates in a National Military Command Center-like environment.

Decision templates are prestructured procedural aids for evaluating various alternative courses of action available to a decision maker. The templates assist the decision maker in selecting the course of action which is wholly consistent with judgments concerning the satisfaction of goals and evidence concerning the outcome of future events. The templates described herein are based upon the analytical methodology of decision analysis and are embedded in interactive computer software designed to be used by operational, vice technical, personnel.

During the period 1976-1978, under the sponsorship of the Defense Advanced Research Projects Agency (DARPA), Decisions and Designs, Inc. (DDI) designed, implemented, and tested successfully a family of computer-based decision aids at the headquarters of the U.S. European Command and its component commands of the Army, Navy, and Air Force. The decision templates described herein are logical extensions, tempered by operational experience, of those prototype decision aids.

Objectives

The research program had three objectives: (1) to redesign and improve the prototype decision aids; (2) to

evaluate the improved aids by conducting controlled environment experiments with operational decision-making staffs; and (3) to investigate the implications of incorporating decision templates in military command and control systems.

Each objective is discussed separately in the remaining sections of this summary.

The Decision Aids

Two new decision template aids were designed: OPSEL (option selection) and R-SCREEN (rapid screening of options). The design of the two aids differed on several parameters: the amount of time available for analysis, required user expertise in decision analysis, and the treatment of uncertainty.

For example, R-SCREEN was designed to support those situations wherein less than two hours is available for reaching a decision and the user has virtually no technical familiarity with decision analysis. Accordingly, R-SCREEN does not treat the uncertainty surrounding the decision situation explicitly. On the other hand, OPSEL was designed to support those situations wherein two to four hours are available for analysis and the user has a substantial degree of technical expertise with decision analysis. Accordingly, OPSEL requires an explicit treatment of uncertainty.

During the course of the research a third decision aid, SELECT (information selection), was designed to support an unexpected operational requirement. However, unlike OPSEL and R-SCREEN, which are both aids for decision making, SELECT is an aid for information reduction. SELECT permits a user to create a data base and to retrieve information from the data base in accordance with several selected qualifiers.

Evaluation of the Aids

The research plan called for the aids to be evaluated during the period April to November 1979 by operations officers within the Joint Operations Division of the Joint Chiefs of Staff (JCS). Due to practical considerations and various constraints not under the control of the researchers, the OPSEL aid was not evaluated. The SELECT aid received scant use and, because it was not a decision aid, it was not evaluated either. Thus, the evaluation concentrated on the R-SCREEN aid. Unfortunately, however, R-SCREEN received only limited use within the Joint Operations Directorate. Therefore, to ensure a more thorough and valid evaluation, the R-SCREEN aid was used also in controlled experiments conducted at the National Defense University during October and November 1979.

The evaluation results suggest that the R-SCREEN aid proved useful, but not very usable, to Defense decision makers and their staffs. R-SCREEN was found useful because it served as a convenient checklist for action selection and required judgments similar to the kind that the user would ordinarily make in military crisis decision situations. Furthermore, R-SCREEN provided useful analytical capabilities, such as sensitivity analyses, that were previously not available to the user. We believe that R-SCREEN proved not very usable because it did not adequately motivate the user. For example, the users found the man-machine interface cumbersome. Also, limitations of conversational interaction with R-SCREEN forced the user into a mode of operation which encouraged sequential thought and disrupted creativity.

Because the aid proved useful, we believe that a second-generation R-SCREEN decision aid should be developed. The improved aid should embody a simplified data entry technique, colored graphical displays, audible response, and

incorporate a totally re-entrant program. If the aid embodies these features, we believe that R-SCREEN will motivate voluntary usage and, most importantly, improve the quality of crisis action decisions.

Incorporating Decision Templates in Military Command and Control Systems

Fulfillment of the final objective, assessing the implications of incorporating decision templates in military command and control systems, involved two activities: first, conducting several real-world decision analyses with the participation of the contract sponsor and, second, investigating the current crisis action system used by the JCS. Each activity is discussed below.

Incorporating Decision Templates in Decision Analysis Studies - Five decision analysis studies of real decision problems were conducted during the course of the research program. One analysis, conducted with officers of the J-5 Directorate of the JCS, addressed the El Salvador crisis that arose while the evaluation was proceeding in the Joint Operations Division. The analysis used two precursors of OPSEL--the OPINT (operations and intelligence) and TREE (decision tree) decision aids.

The other decision analyses addressed problems of site selection, test-bed location, selecting a research and development investment strategy, and evaluating requirements for automated data processing support of crisis action functions. All four analyses were conducted for the research sponsor, the Defense Communications Agency (DCA).

Crisis Action System Symposium - The DCA convened a Crisis Action System Symposium in July 1979. The conferees addressed problems associated with the development of courses

of action, planning and initiating the execution of the selected course of action, and monitoring the execution.

Based on this symposium and our experiences with crisis decision makers, we believe that computer support is essential for the generation of courses of action and crisis deployment management. Unfortunately, computer support in crisis action historically has focused only on operational reporting and status keeping. That support has been notably unresponsive to senior staff personnel responsible for developing, recommending, and managing specific courses of action.

We recommend that prestructured sets of options and decision templates be used in crisis action decision-making situations and that, through a common decision analysis framework using video teleconferencing and shared graphics, the JCS and the relevant Joint Commanders contribute their own experienced judgments early in the option generation process. We recommend that operational experiments be initiated to determine the practical and technical feasibility of that approach.

In conclusion, we are convinced, based upon the research findings and our own experiences with decision templates in operational settings, that decision templating methodology provides the means to meet the DCA's goal of improving the communication and processing of information and the quality of national security decision making in crisis action situations. We recommend continued research to support that worthy goal.

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THE DECISION TEMPLATE CONCEPT

1.0 INTRODUCTION

This report describes a program of research conducted by Decisions and Designs, Inc. (DDI) for the Command and Control Technical Center, Defense Communications Agency (DCA) under contract with the Office of Naval Research (ONR). The purpose of the research was to conduct a series of controlled environment experiments to demonstrate and evaluate computer-based decision templates in a National Military Command Center (NMCC)-like environment.

1.1 Background

Complex, important decision problems require sound decision making in the face of inconclusive evidence, conflictive goals and unclear personal judgments. In solving such problems, the decision maker's objective is to choose that course of action which is most consistent with the assessments of the evidence concerning the outcome of future events and judgments concerning the satisfaction of goals.

In most important decision problems, the decision maker is operating under a severe time constraint and with incomplete information, so that unusual pressures bear on the entire decision-making staff and opportunities abound for misperception, misunderstanding, and miscommunication. Those pressures and opportunities are magnified in crisis decision-making contexts. To minimize their effects, decision makers need to employ effective decision-making strategies to ensure that the ultimate decision choice is consistent with the intelligence assessments and the goals at hand.

One such strategy is to use decision analysis methodology. Decision analysis is a formal discipline for improving the overall efficiency and effectiveness of complex decision-making processes.[1] Simply put, the discipline assists decision makers in choosing between alternative courses of action by systematically partitioning the problem and quantifying and examining the implications of the relevant considerations, however subjective and tenuous they may be, that bear on the decision situation.

The overall goal of decision analysis is to ensure that the ultimate decision choice is a fully coherent one, that is, a choice fully consistent with the organizational objectives, value structure, and beliefs. In addition, the inherently quantitative framework imposed by decision analysis serves the decision-making process in several other ways. For example, the approach clarifies and makes explicit the important subjective value structure and rationale underlying the decision problem. That process, in turn, builds additional insight into the problem, promotes accountability in the decision-making process, and facilitates communication and understanding among all of those involved in the process.

Under sponsorship of the Defense Advanced Research Projects Agency (DARPA) and monitoring by the Office of Naval Research, DDI has, over a number of years, developed several

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[1] The literature on decision analysis is vast. For an introductory treatment, the reader should refer to Howard Raiffa, Decision Analysis (Reading, Massachusetts: Addison Wesley, 1968); Dennis V. Lindley, Making Decisions (London: Wiley, 1971); Rex V. Brown, Andrew S. Kahr, and Cameron R. Peterson, Decision Analysis for the Manager (New York: Holt, Rinehart, and Winston, 1974); or Scott Barclay; Rex V. Brown; Clinton W. Kelly; Cameron R. Peterson; Lawrence D. Phillips; and Judith Selvidge, Handbook for Decision Analysis, Technical Report TR-77-6-30 (McLean, Virginia: Decisions and Designs, Inc., 1977).

classes of computer-based decision-aiding models to assist Defense decision makers. The feasibility of embedding decision-analytic techniques in computer software and using the programs as decision aids in a command post environment was tested successfully during the period 1976-1979 at several large U.S. military headquarters in the European theatre. The computerized versions of normative decision analysis processes permitted the rapid, numerical evaluation of decision options by means of software programs that implement standard decision-analytic procedures in which classical decision tree formats are replaced by simplified evaluation formats called decision templates.

The decision templates permit decision makers and their staffs to employ prestructured evaluation formats to expedite the decision-making process when the available time is very short. The templating procedure also identifies the problem's critical features that are candidates for more detailed analysis and hypothesis testing should additional time become available.

Based upon our actual experience with a number of military crisis management problems, we note that although many different international situations or confrontations can be expected to arise, only a few different types or classes of crisis management problems will actually confront Defense decision makers. For example, one type of crisis problem has arisen in many different forms during the past several years: the safe evacuation of U.S. personnel overseas. The problem for the decision maker has been whether, when, and how U.S. personnel should be removed to safety when confronted with a particularly ominous international development. For a specific class of problems such as evacuation, each particular situation will vary widely depending upon the geographical area, the nature of the operating environment, and the number and type of forces to be involved, but

the evaluation criteria remain relatively stable. Examples of other similar classes of problems include the responses to blockades, reactions to highjacking operations, provisions for emergency military support to a client state, show of force, and responses to terrorist activities.

Although numerous situational variables are possible for each crisis, the analysis and evaluation process will be practically the same for each class of problems. The crisis decision-making process, therefore, is ideally suited for the use of prestructured decision templates. Furthermore, the use of decision templates in crisis decision making facilitates communication among different organizational and staff elements. The method highlights precisely where disagreements exist and by how much and what difference the disagreements might make. This enhanced communication among staff elements facilitates battle staff integration, reduces the chance of critical misunderstandings, and enhances the likelihood of a successful outcome. In addition, by organizing the dialogue and debate among the crisis management team, the methodology substantially accelerates the development of a sound recommendation; the staff is not likely to be overwhelmed by tangential events.

In summary, decision templating is a formal procedure for structuring the judgments which would normally be made by an operational staff in times of crisis. The methodology requires that the staff members identify alternative courses of action, that they consider various uncertainties which could affect the consequences of choosing any particular course of action, that they describe the consequences associated with each course of action and each possible outcome, that they identify criteria against which these consequences can be evaluated, and that they encode these consequences and key uncertainties numerically so that sensitivity

analyses can be carried out to develop a recommended course of action.

Some of these steps can be carried out intuitively or by using pencil-and-paper methods. However, we believe that the implementation of a computerized templating procedure provides several advantages. First, the computer permits the calculations necessary to evaluate each possible course of action to be repeated many times to test, at the discretion and direction of the user, the effect of changes in the input information. In addition, the computer program acts as a recording device by keeping track of and displaying the lists of options, outcomes, and value dimensions as the problem is developed, thus facilitating the development and understanding of the problem, the structure for its analysis, and its solution.

1.2 Research Objectives

The objectives of the research program were threefold: first, to redesign the first generation of decision template software developed under DARPA support and thereby create a second generation of improved decision aids; second, to conduct experiments with real-world crisis decision-making staffs to evaluate the new templates and obtain recommendations for further improvements and extended applications; and third, to investigate the implications of incorporating decision templates in military command and control systems.

The long-term objective--assuming the research described herein is judged successful--is that a future crisis decision maker confronted, for example, with a potential evacuation problem would be able to access the evacuation template program on a World Wide Military Command and Control System (WWMCCS) computer terminal and input the situational variables that characterize those problem elements

unique to the current situation: the operating environment, forces available, number of potential evacuees, and critical political and military objectives and constraints. Having received that information, the template program would then assist battle staff personnel in eliciting from the appropriate WWMCCS data bases the critical information needed to update and adapt the generalized evacuation template to the existing situation. Once updated with current information, the program would then lead staff personnel through a series of hypothetical outcome analyses and possible value trade-offs so that they could evaluate and display the implications of different U.S. actions, given the objectives to be achieved, the uncertain operating environment and the inherently complex nature of the political-military situation. Ultimately, the interaction would result in the identification and adoption of a course of action coherent with the situation. It must be emphasized that the use of the templating procedure in no way replaces the informed and experienced judgment of the decision maker; rather, the templating procedure aids that judgment.

1.3 Organization of This Report

The common theme throughout the research and this report is that of aiding the judgment of those who must analyze and resolve crisis decision problems. Following that theme, the reader will find that this report has three logical parts: the design and experimental application of decision templates (Sections 2.0 and 3.0), problem solving using decision-aiding methodology (Section 4.0), and implications for the use of decision templates in support of crisis action (Sections 5.0 and 6.0).

The possible incorporation of decision template software into the WWMCCS computers is a future decision that is dependent on the assessment of the research results reported

both here and elsewhere. However, as we discuss in detail in Section 3.4 and Section 6.0, we conclude that the templating procedures developed in this research effort, further refined to facilitate the required man-computer interaction, would provide much needed assistance to those officials responsible for crisis action. We believe that the use of decision templates will lead to optimal, rather than just satisfactory, crisis actions.

2.0 TECHNICAL APPROACH

The technical approach used in the research involved six phases: the preliminary designs of two distinct decision template aids, a review of the preliminary designs by external advisors and consequent revisions to the aids, formal briefings and demonstrations of the aids to senior Defense decision makers, formal training and on-the-job applications, finalization of the designs, and evaluations of the aids. These six phases are discussed below.

As the research proceeded, unexpected opportunities arose for exploratory development and study. For example, the practical application of the two decision template aids established the need for the development and limited testing of a third decision aid. In addition, the research sponsor was able to apply and evaluate the decision-aiding technology to several disparate live decision problems, including contingency planning for crisis action. Those applications are discussed in Section 4.0. The implications for future crisis action support are discussed in Sections 5.0 and 6.0.

2.1 Preliminary Template Designs

Based upon previous basic research and exploratory development conducted for DARPA, two new decision template aids were designed to extend the decision template concept. The aids, named OPSEL and R-SCREEN, were programmed in the APL computer language to run interactively on an IBM 5110 minicomputer.

OPSEL was designed for users well trained in decision analysis for use in those crisis situations where uncertainty is a key determinant of choice, and two to five hours

are available for problem analysis. Thus, the OPSEL aid supports a knowledgeable user having several hours to respond to crisis situations involving key uncertainties. R-SCREEN, on the other hand, is a simpler aid to use and is designed for those less knowledgeable in decision analysis who must respond to a crisis situation in less than two hours. The two aids are described in Section 3.0.

2.2 Review and Revisions of the Designs

The preliminary designs for OPSEL and R-SCREEN were reviewed with key personnel of the J-3 Division of Headquarters, U.S. European Command (EUCOM). Those personnel had extensive experience in using similar decision aids in actual crisis situations that arose during the three-year period 1976-1979.

Based upon the recommendations obtained from the EUCOM staff officers, several key revisions were made to the preliminary designs of OPSEL and R-SCREEN.

2.3 Formal Briefings and Demonstrations

The revised designs were briefed to personnel of the WWMCCS ADP Utility Research Office and other officers of the Defense Communications Agency, and to key personnel of the Organization of the Joint Chiefs of Staff (JCS). More than thirty JCS staff officers were briefed, as were the following senior personnel: LTGEN P. Shutler, USMC, Director of Operations; MG J. O'Malley, USAF, Vice Director of Operations; RADM A. Kellin, USN, Deputy Director for Strategic Operations; MG V. Doubleday, USAF, Deputy Director for WWMCCS; RADM M. Schultz, USN, Assistant Deputy Director for WWMCCS; BGEN J. Johnson, USA, Deputy Director for Current Operations; BGEN A. Walter, USAF, Deputy Director for the National Military Command Center.

2.4 Formal Training and On-the-Job Application

To implement the aids, an IBM 5110 minicomputer with associated peripheral equipment was installed in the normal working spaces of the Joint Operations Division (JOD) of the JCS from 10 April until 8 November 1979. Formal training sessions on the use of the equipment and the R-SCREEN and OPSEL decision aids were scheduled and conducted at the JOD during April and May and at DDI in June and July. The formal sessions were not well attended, and those officers who did attend the sessions conducted at the JOD rarely sat through the entire session without an interruption because of telephone calls or pressing business.

On-the-job training sessions were scheduled and conducted during a two-hour period once each week from April through November. Once again the press of JOD business interferred significantly with these training sessions. It was the authors' shared opinion that because of (1) the inability to hold the attention of the JOD officers assigned to work with the aids, (2) the JOD officers' lack of initiative in familiarizing themselves with the background and capabilities of the aids, and (3) the depth of specialized knowledge required by the OPSEL aid, the concentration of research effort should be restricted to just one aid: R-SCREEN. Consequently, with the contract sponsor's approval, on-the-job training at the JOD was confined to the use of the R-SCREEN decision aid.

Nevertheless, OPSEL and its predecessor aids, OPINT and TREE, were used in an analysis of the El Salvador crisis that occurred during the period of application and which is described in Section 4.1 of this report. However, the analysis was conducted with officers from the J-5 Directorate of the JCS rather than with officers from the JOD.

2.5 Finalization of the Design

Based upon the experience gained from working with the JOD officers, additional modifications were made to the design of the R-SCREEN aid. The design was finalized during July, at which time a draft copy of a users manual was printed and distributed to prospective users for comment. The modified final version of the R-SCREEN users manual was published in October 1979.[1]

2.6 Evaluation of the Aids

The evaluation process was also restricted to the R-SCREEN aid. Because of the difficulty of scheduling the time of the JOD officers, however, the evaluation utilized senior military and civilian students of the Industrial College of the Armed Forces (ICAF) plus one ICAF faculty member and one civilian from the Defense Communications Agency. The formal evaluation process was conducted at ICAF during September and October 1979 under separate DCA contract by Dr. Andrew P. Sage and Dr. Chelsea C. White, III, members of the faculty of the University of Virginia; the evaluation results are described in their final report.[2]

2.7 SELECT--A Third Decision Aid

During the on-the-job training in the use of R-SCREEN, at the request of a JOD officer and with the approval of the

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[1] Gulick, Roy M. and Allardyce, Linda B. Documentation of Decision-Aiding Software: R-SCREEN Users Manual. Users Manual UM 79-3-99. McLean, VA: Decisions and Designs, Inc., October 1979.

[2] Sage, Andrew P. and White, Chelsea C., III. Evaluation of Two DDI Decision Aids Developed for DCA:C140. Document Number 33737-W114-RU-00. Falls Church, VA: TRW Defense and Space Systems Group, January 1980.

sponsor, a third decision aid was designed and added to the repertoire of aids available within the JOD. The aid, known as SELECT, enables the user to create a data base of relevant information on some subject of importance and then to retrieve information from the data base in accordance with several selected qualifiers. More than one data base may be created and searched. SELECT, which received only very limited use during its residence at JOD, is described in Section 3.3.

3.0 DECISION AIDS

Three interactive computer-based decision aids were developed, tested, and evaluated during the course of the contract. Both the design and the development of two of the aids were planned in advance as an integral part of the contract. The development of the third aid was unforeseen; that aid was designed spontaneously to satisfy a specific functional requirement that arose during the testing and evaluation of the other two aids.

The two planned aids, OPSEL (option selection) and R-SCREEN (rapid screening of options), provide assistance for the same kind of decision problem, that is, choosing one of several alternative courses of action (options) in response to a crisis situation. However, the procedural approaches that OPSEL and R-SCREEN use to assist the decision maker in making that choice differ significantly. The difference was mandated by two variable factors surrounding crisis decision problems: first, the amount of time available for a decision analysis and, second, the degree of user familiarity with the technical approach embodied by the aid.

OPSEL, for example, is a more robust decision aid than R-SCREEN. It permits the user greater flexibility in modeling the problem, treats the key uncertainties of the problem explicitly, and provides the user a richer set of sensitivity analyses. OPSEL's robustness exacts its price, however, because an OPSEL decision analysis requires more time than does one performed using R-SCREEN, and it also requires a user more familiar with the principles of decision analysis and more skilled in the procedural approach used by the aid.

The third aid, SELECT, was developed to address quite a different kind of problem: extracting highly selected

information from a data base. For example, given a collection of diverse data about Cuban military installations, a crisis decision maker may want to extract and list certain characteristics (such as the name, location, and complement) of all military airfields with improved runways of length greater than 3,000 feet in the northwest half of the island. The SELECT aid was designed to perform information extraction of that kind.

The three aids--OPSEL, R-SCREEN, and SELECT--are discussed in the following three sections. The discussions are followed by conclusions and recommendations concerning the use of the aids in crisis decision-making situations.

3.1 The OPSEL Decision Aid

3.1.1 Background - A political-military crisis situation is often characterized by a range of options, key future uncertainties, and multiple conflicting goals and objectives. In such situations the responsible decision maker strives to collect and assess information relevant to the courses of action under consideration and to choose that one course of action which is most consistent with the organizational goals and values and the intelligence concerning the likelihood of future developments. OPSEL was designed to support that process--to aid crisis decision makers assess the implications of information for decision choice. OPSEL's design was based on earlier decision aids that had proved useful in real-world crisis situations.

3.1.2 Objective - OPSEL is an interactive computer-based decision aid that enables a user to construct and exercise a decision model of a crisis situation and thereby examine the implications for decision choice. The model assists the user in organizing the problem, resolving issues

of uncertainty and conflicting value, and explicating the pertinent rationale.

The overall design objective was to permit a relatively knowledgeable user to perform a complete OPSEL analysis in three to four hours. To help satisfy that objective, OPSEL was designed as a menu-driven system (permitting the user to interact with the computer by choosing options from a menu display) and one that is generally forgiving of procedural errors in entering data.

3.1.3 The OPSEL model format - OPSEL requires the user to construct a decision model using a decision tree format, as depicted in Figure 3-1. OPSEL restricts the tree to one decision followed by one key uncertainty.

The OPSEL format requires that the user supply a list of the alternative courses of action (CA_1, CA_2,...CA_n), a list of the possible event outcomes of the key uncertainty (E_1, E_2,...E_m), the probability of each event outcome conditioned by the chosen course of action [$P(E_i|CA_j)$], and the overall regret associated with each possible decision outcome [$R(CA_j|E_i)$].

In arriving at the value of overall regret associated with each possible decision outcome, the user may identify a list of specific criteria and their relative importances and then define the regret of each outcome with respect to each criterion. OPSEL will automatically combine, in a linear-additive fashion, the separately assessed regrets into an overall value of regret.

The user must specify regrets on a scale ranging from -100 (most regret/greatest loss of opportunity) to 0 (no regret/no loss of opportunity). OPSEL assists the user in assigning values of regret.

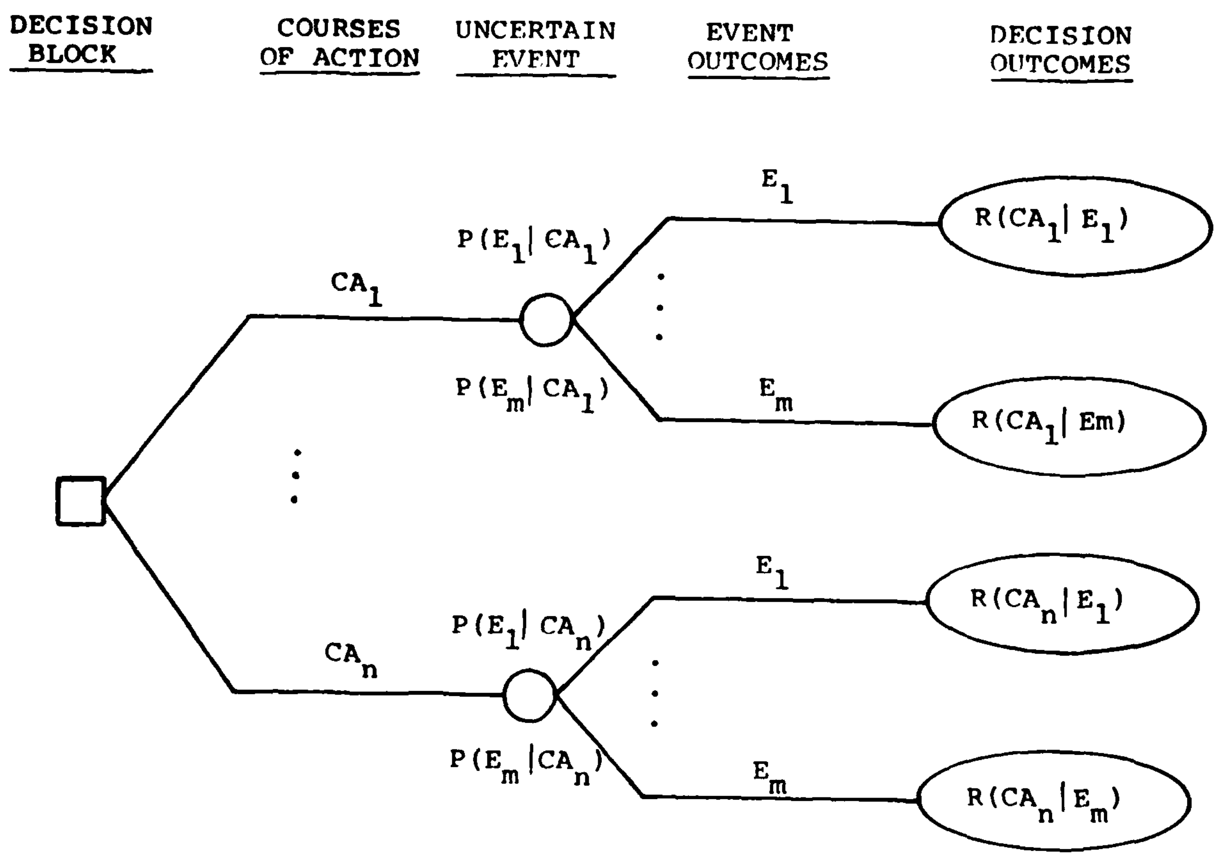

Figure 3-1
THE OPSEL DECISION MODEL FORMAT

Consistent with the assessed regrets, importance weights, and probabilities, the user should choose that course of action which leads to the least-expected regret.

3.1.4 Description of the aid - The OPSEL software consists of two distinct subsystems: RUN and SENS. The RUN subsystem is used to create a new decision model, to display the results of an existing model, and to revise an existing model. The SENS (sensitivity) subsystem is used to perform various sensitivity analyses on an existing decision model.

To illustrate the use of the two subsystems, assume that a user has structured a crisis decision problem involving the suspected presence of missiles in a small adversary country. The model structure, depicted in Figure 3-2, shows three alternative courses of action: to RAID, to WARN, and to WAIT. There is one key uncertainty: whether or not missiles are actually present (and will be used).

To construct a computer-based model using OPSEL, the user must start with the RUN subsystem.

3.1.4.1 The RUN subsystem - Having selected the RUN subsystem, the user is presented the menu of options shown in Table 3-1.

Upon selecting option 5, CREATE NEW MODEL, the user must identify the action options (courses of action), name the key uncertain event and its possible outcomes, and list the criteria to be used to assess the value of the decision outcomes. The corresponding man-machine dialogue is listed in Table 3-2. For ease of presentation, the user's typed responses have been underlined.

Next the user must input the values of regret associated with each decision outcome. The regrets

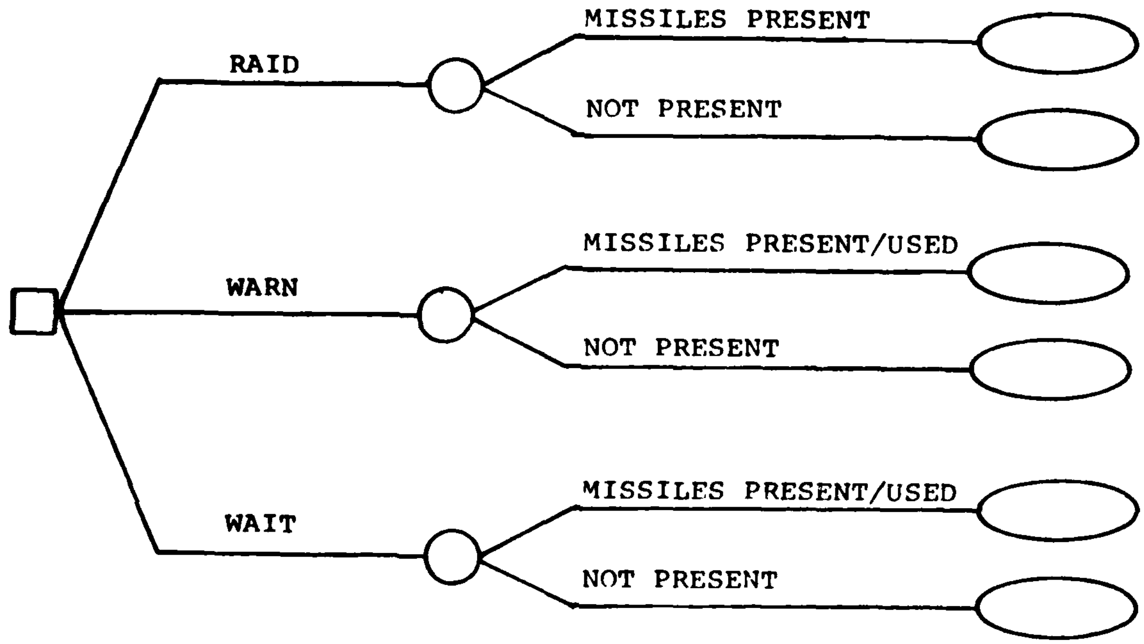

Figure 3-2
A HYPOTHETICAL DECISION STRUCTURE

THE FOLLOWING OPTIONS ARE AVAILABLE:

1) DISPLAY RESULTS
2) REVISE ESTIMATES
3) SENSITIVITY
4) LOAD MODEL
5) CREATE NEW MODEL
6) SAVE MODEL

Table 3-1

RUN SUBSYSTEM MENU OF OPTIONS

```
LIST THE DECISION ACTION OPTIONS:

[RAID    ]
[WARN    ]
[WAIT    ]
[        ]
ACTION OPTIONS:

 1) RAID
 2) WARN
 3) WAIT

ARE THESE LABELS CORRECT?  YES
WHAT IS THE NAME OF THE UNCERTAIN EVENT?
[MISSILES   ]
UNCERTAIN EVENT:

 1) MISSILES

ARE THESE LABELS CORRECT?  YES
LIST THE POSSIBLE OUTCOMES OF THE UNCERTAIN EVENT.
[PRES   ]
[NOT    ]
[       ]
OUTCOMES:

 1) PRES
 2) NOT

ARE THESE LABELS CORRECT?  YES
WHAT ARE THE CRITERIA?
[FOR AFF  ]
[DOM AFF  ]
[NATL SEC ]
[         ]
CRITERIA:

 1) FOR AFF
 2) DOM AFF
 3) NATL SEC

ARE THESE LABELS CORRECT?  YES
```

Table 3-2

AN INTERACTIVE DIALOGUE

are elicited for one criterion at a time. Table 3-3 shows the regrets elicited for the Foreign Affairs (FOR AFF) criterion. Note there are two outcomes for which the user has no regret.

	FOR AFF	
	PRES	NOT
RAID	0	-100
WARN	-70	-30
WAIT	-90	0

Table 3-3

VALUES OF REGRET

When the regrets have been specified for all of the criteria, OPSEL simultaneously displays the best (0) and worst (-100) decision outcomes for each criterion and asks the user to consider the impacts of the differences between best and worst and then assign appropriate importance weights to the criteria. That dialogue is shown in Table 3-4. The implication is that the impact on

ENTER THE WEIGHTS ASSOCIATED WITH THE VARIOUS CRITERIA:

	FOR AFF	DOM AFF	NATL SEC
	NOT	NOT	PRES
RAID	-100	-100	0
WARN	-30	0	-80
WAIT	0	-5	-100
WEIGHTS	25	25	50

Table 3-4

RELATIVE IMPORTANCE WEIGHTS

Foreign Affairs (FOR AFF) equals that on Domestic Affairs (DOM AFF), and that their combined impact equals that of National Security (NAT SEC).

Finally, the user must specify for each course of action the probabilities of the uncertain event outcomes. That dialogue is shown in Table 3-5.

```
DO THE PROBABILITIES OF THE OUTCOMES OF THE KEY UNCERTAINTY
DEPEND UPON THE ACTION TAKEN?  YES
ENTER PROBABILITIES OF THE VARIOUS OUTCOMES FOR EACH ACTION:

               PRES    NOT
RAID           80      20
NORMALIZED       80      20
ARE THESE NORMALIZED VALUES CORRECT?  YES

               PRES    NOT
WARN           70      30
NORMALIZED       70      30
ARE THESE NORMALIZED VALUES CORRECT?  YES

               PRES    NOT
WAIT           50      50
NORMALIZED       50      50
ARE THESE NORMALIZED VALUES CORRECT?  YES
          LIKELIHOOD OF
               PRES    NOT
RAID             80      20
WARN             70      30
WAIT             50      50
```

Table 3-5

CONDITIONAL PROBABILITIES

An OPSEL model has now been created, and the user is once again shown the menu options listed in Table 3-6. Corrections to the model can be made by selecting menu option 2; option 1 is used to display the results of the model.

THE FOLLOWING OPTIONS ARE AVAILABLE:

1) DISPLAY RESULTS
2) REVISE ESTIMATES
3) SENSITIVITY
4) LOAD MODEL
5) CREATE NEW MODEL
6) SAVE MODEL

Table 3-6

RUN SUBSYSTEM MENU OF OPTIONS

Upon selecting option 1, DISPLAY RESULTS, the user is presented the secondary menu listed in Table 3-7. The secondary menu lists all of the results that can be examined.

THE FOLLOWING DISPLAYS ARE AVAILABLE:

1) EXPECTED VALUE
2) COMBINED VALUE
3) EVENT LIKELIHOOD
4) VALUES
5) CRITERIA WEIGHTS

ENTER THE NUMBER OF THE DESIRED OPTION:

Table 3-7

OPTIONS FOR DISPLAYING RESULTS

For example, the combined regret matrix (aggregate of the weighted criterion regrets) is shown in Table 3-8.

The implication of Table 3-8 is that if missiles are present then RAID is the best option; if missiles are not present then WARN is the best option.

	COMBINED VALUE PRES	NOT
RAID	0	-70
WARN	-73	-8
WAIT	-91	-11

Table 3-8

COMBINED VALUE REGRET MATRIX

Table 3-9 incorporates the degree of uncertainty and shows the expected value of regret associated with each course of action. The implication of Table 3-9 is that, consistent with the specified regrets and event probabilities, the preferred course of action is to RAID, since it has the least expected regret (a total regret of -14 versus the regrets of -53 and -51 associated with the other two options).

	EXPECTED VALUE PRES	NOT	TOTAL
RAID	0	-14	-14
WARN	-51	-2	-53
WAIT	-46	-6	-51

Table 3-9

EXPECTED VALUE REGRET MATRIX

Having examined the results, the user may now want to store the model for future use by selecting main menu option 6, SAVE MODEL. Once the model is saved, the user can use the SENS subsystem to perform various sensitivity analyses on the results.

3.1.4.2 <u>The SENS subsystem</u> - Having selected the SENS subsystem, the user is presented the menu of options shown in Table 3-10.

```
THE FOLLOWING OPTIONS ARE AVAILABLE:

 1) DETERMINE THRESHOLDS
 2) MANUALLY CHANGE PROBS
 3) TWO-POINT ESTIMATION
 4) COMPUTE DIFFERENCE RATIOS
```

Table 3-10
SENS SUBSYSTEM MENU OF OPTIONS

Selecting option 1, DETERMINE THRESHOLDS, results in a secondary menu being displayed, as shown in Table 3-11. Both options 1 and 2 will display a matrix showing the expected value of regret for each course of action as a function of either the probability of a selected event or the importance weight of a selected criterion.

```
THE FOLLOWING OPTIONS ARE AVAILABLE:

 1) VARY EVENT PROB
 2) VARY CRITERION WT
 3) VARY SIMULTANEOUSLY
```

Table 3-11
THRESHOLD SENSITIVITY OPTIONS

Table 3-12 illustrates both of the displays and shows the expected regrets as a function of the importance weight assigned to National Security. For any particular weight shown in the table, the asterisk identifies the preferred

course of action; the arrow at the bottom indicates a threshold value at which the preferred course of action changes. Thus WAIT is the preferred course of action until the weight of National Security reaches 10%, at which the preferred course of action becomes (and remains) to RAID.

	EXPECTED VALUE WHEN THE WEIGHT OF NATL SEC IS:										
	0	10	20	30	40	50	60	70	80	90	100
RAID	-20	-19*	-18*	-16*	-15*	-14*	-13*	-12*	-10*	-9*	-8*
WARN	-42	-44	-46	-49	-51	-53	-55	-57	-60	-62	-64
WAIT	-19*	-25	-32	-38	-45	-51	-58	-64	-71	-77	-84
		↑									

Table 3-12

THRESHOLD SENSITIVITY ANALYSIS (VARIED CRITERION WEIGHT)

Option 3, vary simultaneously, permits the user to vary both the probability of an event and the weight of a criterion simultaneously. The resulting display is shown in Table 3-13. The numbers in the matrix identify the preferred course of action (identified in the legend) as a function of both the probability that missiles are present and the weight assigned to National Security interests. Note that the corresponding probability of the other event outcome (NOT PRESENT) and the weights of the other two criteria are also displayed.

Returning to the main menu option of SENS, as shown once again in Table 3-14, the user can select option 2 to manually input some trial probabilities and observe the associated expected regrets, as shown in Table 3-15.

```
OPTIMAL REGIONS WHEN EVENT=    PRES
VARIES WITH WEIGHT= NATL SEC


     NOT
      0   P 100:111111111111111111111111111111111
     10   R 90 :111111111111111111111111111111111
     20   O 80 :111111111111111111111111111111111
     30   B 70 :111111111111111111111111111111111
     40   ↓ 60 :111111111111111111111111111111111
     50     50 :222222222222111111111111111111111
     60     40 :333222222222222222222222111111111
     70     30 :333333222222222222222222222222222
     80   P 20 :333333333222222222222222222222222
     90   R 10 :333333333333222222222222222222222
    100   E 0  :333333333333222222222222222222222
                ..  ..  ..  ..  ..  ..  ..  ..  ..  ..  ..
                0  10  20  30  40  50  60  70  80  90 100
                      WEIGHT→ NATL SEC

FOR AFF         50  45  40  35  30  25  20  15  10   5   0
DOM AFF         50  45  40  35  30  25  20  15  10   5   0
```

<u>LEGEND:</u>

```
RAID     1
WARN     2
WAIT     3
```

Table 3-13

THRESHOLD SENSITIVITY ANALYSIS
(PROBABILITY AND WEIGHT VARIED SIMULTANEOUSLY)

THE FOLLOWING OPTIONS ARE AVAILABLE:

1) DETERMINE THRESHOLDS
2) MANUALLY CHANGE PROBS
3) TWO-POINT ESTIMATION
4) COMPUTE DIFFERENCE RATIOS

Table 3-14

SENS SUBSYSTEM MENU OF OPTIONS

```
                             PRES      NOT
CURRENT
PROBABILITY                   80        20
TRIAL PROBS:                  50        50
TRIAL PROBS:
ARE THESE VALUES CORRECT?    (Y/N): ?  Y

NORMALIZED ESTIMATES ARE:
   PRES     80     50
    NOT     20     50
       A REVIEW OF COMPUTED RESULTS:
                0     1
RAID          -14   -35
WARN          -53   -40
WAIT          -51   -51
```

Table 3-15

TRIAL PROBABILITIES AND ASSOCIATED REGRETS

Menu option 3, TWO-POINT ESTIMATION, calculates expected regrets between two sets of probabilities, as shown in Table 3-16.

```
                        PRES      NOT
SET #1                   50         50
SET #2                  100          0
NORMALIZED ESTIMATORS ARE:
SET #1                   50    50
SET #2                  100     0
ARE THESE VALUES CORRECT?   (Y/N): ?  Y

A REVIEW OF YOUR ESTIMATES:
   PRES      50    60    70    80    90    100
    NOT      50    40    30    20    10      0
 THE COMPUTED RESULTS:
              1     2     3     4     5      6
RAID        -35   -28   -21   -14    -7      0
WARN        -40   -47   -53   -60   -66    -73
WAIT        -51   -59   -67   -75   -83    -91
```

Table 3-16

TWO-POINT ESTIMATION

The selection of menu option 4, COMPUTE DIFFERENCE RATIOS, causes a secondary menu to be displayed, as shown in Table 3-17.

```
THE FOLLOWING DISPLAYS ARE AVAILABLE:

 1) DIFFERENCE MATRICES
 2) COMBINED-DIFFERENCE MATRIX
```

Table 3-17
MENU FOR DIFFERENCE RATIOS

The user may examine the sensitivity of either a particular criterion (option 1) or the combined weighted criteria (option 2). A typical result is shown in Table 3-18, the combined difference matrix.

	PRES	NOT
RAID	-46	-185
WARN	56	132
WAIT	74	74

Table 3-18
COMBINED DIFFERENCE MATRIX

The values of the matrix show the amounts by which any individual combined regret value would have to be altered to cause a change in the preferred course of action.

3.2 The R-SCREEN Decision Aid

3.2.1 Background - As in the case of OPSEL, the R-SCREEN decision aid is intended to serve crisis decision makers in the processing and evaluation of information relating to various alternative courses of action under consideration. Unlike OPSEL, R-SCREEN provides a relatively rigid normative framework (a template) for organizing and analyzing the difficult value trade-offs inherent in crisis decision making. It does not treat uncertainty explicitly.

3.2.2 Objective - R-SCREEN is a decision-analytic, computer-based interactive decision aid that permits the rapid evaluation of several alternative courses of action. R-SCREEN was designed to permit a relatively technically unsophisticated user to complete an analysis in about 90 minutes. As in the case of OPSEL, R-SCREEN is a menu-driven system and one that is relatively forgiving of procedural errors.

3.2.3 The R-SCREEN model format - The R-SCREEN decision-aiding procedure assumes that a decision problem exists and that several alternative courses of action have been proposed as a problem solution. The decision-making task is to evaluate the courses of action and select the one course of action that is most consistent with the organizational goals and values.

Having identified the alternative courses of action, the user must choose one of three R-SCREEN evaluation templates, each of which addresses a different type of operational decision problem. The three templates address the following generic problems:

- o projection of armed force for political purposes;

- posturing armed forces in the face of a possible evacuation operation; and

- choosing among various military options each involving significant risk.

The evaluation mechanism embedded in the templating procedure is that of hierarchical partitioning, that is, separating the overall evaluation task into several major criteria, each of which is partitioned until a level of detail is reached at which the user easily can discriminate among the alternative courses of action. For example, Figure 3-3 shows the template that R-SCREEN imposes for the evaluation of the alternatives in a projection-of-forces problem. The user may make minor alterations to the template as necessary to fit the problem at hand.

For each of the bottom-level criteria shown on the template (for example, node 2.3.1, the simplicity of military operations, in Figure 3-3) the user must specify the most-preferred (a utility of 100) and least-preferred (a utility of 0) courses of action. Appropriate intermediate values of utility are assigned to the other courses of action. R-SCREEN elicits written rationale to support those utility values and stores that rationale as part of the model.

An R-SCREEN model is complete when the user assigns utilities and relative importance weights (with supporting rationale) to the various evaluation criteria. R-SCREEN elicits the importance weights from the user in a systematic fashion, proceeding step by step from the bottom-level criteria to those at the very highest level.

3.2.4 <u>Results</u> - The overall result of an R-SCREEN evaluation is a matrix showing the aggregate utility of each

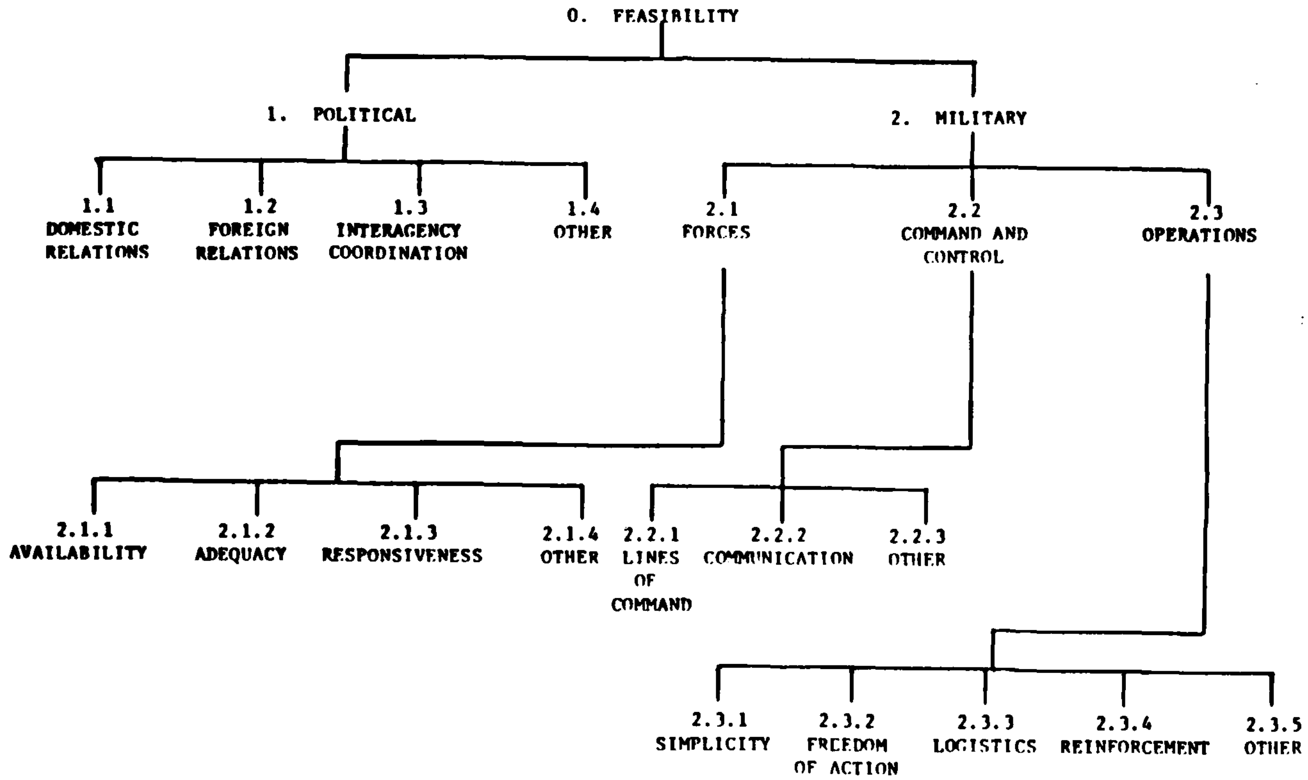

Figure 3-3

PROJECTION OF FORCES FOR POLITICAL PURPOSES

alternative course of action. For example, Table 3-19 shows the overall result for a hypothetical problem with three alternative courses of action.

CA1: TAKE NO ACTION; AWAIT DEVELOPMENTS
CA2: OVERT WARNING IN U.N.; CONCURRENT PRIVATE WARNING
CA3: CONDUCT NIGHT RAID; DESTROY WEAPONS

0 FEASIBILITY

--FACTOR--	WT	CA1	CA2	CA3	CUMWT
1) POLITICAL	(62)	84	60	28	62.0
2) MILITARY	(38)	6	12	71	38.0
--TOTAL--		54	42	44	100.0

Table 3-19
OVERALL RESULTS

The implication is that CA1 is preferred since its total utility (54) is greater than that of CA2 (42) and CA3 (44). Similar displays can be produced with respect to any desired node in the template.

The user can also perform a variety of different sensitivity analyses on the results. Table 3-20, for example, illustrates a swing weight analysis that indicates how the overall results vary as a function of the importance weight assigned to a particular criterion (Command and Control). It shows that the overall result is very sensitive to the criterion being examined, switching from CA2 to CA3 to CA1 as Command and Control issues take on greater importance.

3.2.5 R-SCREEN Users Manual - A complete description of the R-SCREEN aid is contained in the following publication: Linda B. Allardyce and Roy M. Gulick, Documentation of Decision-Aiding Software: R-SCREEN Users Manual, Users

2.2 - COMMAND AND CONTROL CURRENT CUMWT: 11.5

THE MINIMUM CUMWT IS?: 5
THE MAXIMUM CUMWT IS?: 30

2.2 - COMMAND AND CONTROL CURRENT CUMWT: 11.5

WT	CA1	CA2	CA3
5.0	56	74*	70
7.5	57	72*	70
10.0	58	70*	69
12.5	60	68	69*
15.0	61	67	68*
17.5	62	65	67*
20.0	64	63	66*
22.5	65	60	66*
25.0	66*	58	65
27.5	68*	56	64
30.0	69*	55	64

Table 3-20

SWING WEIGHT SENSITIVITY ANALYSIS

Manual UM 79-3-99 (McLean, Virginia: Decisions and Designs, Inc., October 1979).

3.3 SELECT

3.3.1 Background - Military decision makers and their staffs often have the need to obtain highly specified information from a large collection of data. For example, given a collection of data about Soviet Naval ships, a U.S. military commander may need to know which of those ships possess certain specified characteristics of displacement, armament, class, and complement.

In the sense used herein, data is a homogeneous collection of facts; information is a collection of data that has been processed in accordance with a selection procedure and formatted for presentation to the user.

The data may be concentrated in one physical collection, such as a single reference book, or distributed across many collections such as volumes of books. The selection and retrieval of key information from the data collection may be done manually or automatically. In either case, the retrieval process becomes most efficient when the data base has been designed to support the requirements of the information consumer.

As a consumer of information to support crisis management, the JOD of the JCS often must retrieve information from a data collection quickly and accurately. The SELECT decision aid was created to meet that operational requirement.

3.3.2 Objective - SELECT is an interactive computer-based decision aid that enables a user to design and build a specialized data base, store the data for future use, amend the data as necessary, and selectively retrieve key information from the data base. The SELECT system was designed to be used by end users in the JOD who are relatively unsophisticated with respect to computer technology. Accordingly, the design satisfies two human-factors objectives: SELECT is a menu-driven system (requiring the user to choose which of several operations the software should perform) and one that is generally forgiving of procedural errors by the user.

3.3.3 Description of the aid - The SELECT software consists of two distinct subsystems: BUILD and RUN. The BUILD subsystem is used to construct a brand new data base or to amend data residing in an already existing data base. The RUN subsystem is used to correspond with and select information from an already existing data base.

To present a brief overview of the SELECT system, assume that a user has previously used the BUILD subsystem to construct a data base of characteristics about U.S. helicopters. Further, assume that a user now wishes to use the RUN subsystem to extract certain key information from that data base. The man-machine dialogue proceeds as follows.

The RUN subsystem presents the user with a menu of options as shown in Table 3-21.

```
THE FOLLOWING OPTIONS ARE AVAILABLE:

 1) LOAD A DATA BASE
 2) SELECT
 3) PRINT SYNONYMS
 4) PRINT RESULTS
 5) PRINT DATA
```

Table 3-21

RUN SUBSYSTEM MENU OF OPTIONS

First, the user must load the helicopter data base into the computer (other existing data bases could be loaded). That is accomplished by choosing menu option 1. Having loaded the data base, the user then chooses option 3 to retrieve a list of the helicopter characteristics by which information can be retrieved. The resulting list is shown in Table 3-22. Each characteristic has a corresponding synonym for ease of typing the name of the characteristic.

Consulting the list of characteristics and their synonyms, the user next specifies selection restrictions on those characteristics by choosing option 2. The dialogue is shown in Table 3-23. Note that the user was interested only

in determining which helicopters are water-capable. Two helicopters met the water-capable selection criterion.

KEY NAMES	SYNONYMS
RANGE(NM)	R
SPEED(KTS)	S
PASSENGERS	P
PASSENGERS,EMGY	PE
RANGE,MAX(NM)	RM
AIR-REFUELABLE	AR
TANKS,INT/EXT	T
FOLDING-ROTORS	F
ARMAMENT	A
WATER-CAPABLE	W
TRANSP,C-130	C130
TRANSP,C-141	C141
TRANSP,C-5	C5
NUMBER-CONUS	NC
NUMBER-PACOM	NP
NUMBER-HAWAII	NH
NUMBER-SOCOM	NS
NUMBER-EUCOM	NE
SECURE-VOICE	SV
HOIST	H
LOCATION-CONUS	LC
LOCATION-PACOM	LP
LOCATION-HAWAII	LH
LOCATION-SOCOM	LS
LOCATION-EUCOM	LE

Table 3-22
LIST OF HELICOPTER CHARACTERISTICS

Table 3-24 shows a longer dialogue in which several restrictions are placed on the selection. Note that three helicopters met the final selection restrictions. The user then chooses menu option 4 to obtain complete data on the three helicopters meeting the selection restrictions. Table 3-25 shows the results.

```
ENTER CRITERIA :
W=YES
CRITERIA : WATER-CAPABLE=YES

2 SYSTEMS MEET THIS CRITERIA.

DO YOU WISH TO SEE THE SYSTEMS?  YES

  UH-1N
  HH-52
```

Table 3-23

SPECIFICATION OF SELECTION RESTRICTIONS

```
ENTER CRITERIA :
(P≥10)^(R≥250)
CRITERIA : (PASSENGERS≥10)^(RANGE(NM)≥250)

6 SYSTEMS MEET THIS CRITERIA.

DO YOU WISH TO SEE THE SYSTEMS?  YES

  UH-1H
  HH-3
  CH-47C
  HH-52
  HH-53
  UH-60

PRESS EXECUTE TO CONTINUE...

DO YOU WISH TO SPECIFY ADDITIONAL CRITERIA?  YES
ENTER CRITERIA :
LP=YES
CRITERIA : ((PASSENGERS≥10)^(RANGE(NM)≥250))^(LOCATION-PACOM=YES)

3 SYSTEMS MEET THIS CRITERIA.

DO YOU WISH TO SEE THE SYSTEMS?  Y

  UH-1H
  CH-47C
  HH-53
```

Table 3-24

FINAL SELECTION RESTRICTIONS

CRITERIA : ((PASSENGERS$\geq$10)$\wedge$(RANGE(NM)$\geq$250))$\wedge$(LOCATION-PACOM=YES)

UH-IH		CH-47C		HH-53	
RANGE(NM)	250	RANGE(NM)	400	RANGE(NM)	575
SPEED(KTS)	100	SPEED(KTS)	139	SPEED(KTS)	130
PASSENGERS	10	PASSENGERS	33	PASSENGERS	38
PASSENGERS,EMGY	10	PASSENGERS,EMGY	44	PASSENGERS,EMGY	60
RANGE,MAX(NM)	250	RANGE,MAX(NM)	400	RANGE,MAX(NM)	575
AIR-REFUELABLE	NO	AIR-REFUELABLE	NO	AIR-REFUELABLE	YES
TANKS,INT/EXT	NO	TANKS,INT/EXT	NO	TANKS,INT/EXT	YES
FOLDING-ROTORS	NO	FOLDING-ROTORS	YES	FOLDING-ROTORS	NO
ARMAMENT	NO	ARMAMENT	NO	ARMAMENT	YES
WATER-CAPABLE	NO	WATER-CAPABLE	NO	WATER-CAPABLE	NO
TRANSP,C-130	YES	TRANSP,C-130	NO	TRANSP,C-130	NO
TRANSP,C-141	YES	TRANSP,C-141	NO	TRANSP,C-141	NO
TRANSP,C-5	YES	TRANSP,C-5	NO	TRANSP,C-5	YES
NUMBER-CONUS	1671	NUMBER-CONUS	249	NUMBER-CONUS	16
NUMBER-PACOM	185	NUMBER-PACOM	31	NUMBER-PACOM	4
NUMBER-HAWAII	0	NUMBER-HAWAII	0	NUMBER-HAWAII	7
NUMBER-SOCOM	0	NUMBER-SOCOM	0	NUMBER-SOCOM	0
NUMBER-EUCOM	395	NUMBER-EUCOM	50	NUMBER-EUCOM	0
SECURE-VOICE	?	SECURE-VOICE	?	SECURE-VOICE	YES
HOIST	?	HOIST	?	HOIST	YES
LOCATION-CONUS	YES	LOCATION-CONUS	YES	LOCATION-CONUS	YES
LOCATION-PACOM	YES	LOCATION-PACOM	YES	LOCATION-PACOM	YES
LOCATION-HAWAII	?	LOCATION-HAWAII	?	LOCATION-HAWAII	YES
LOCATION-SOCOM	?	LOCATION-SOCOM	?	LOCATION-SOCOM	NO
LOCATION-EUCOM	YES	LOCATION-EUCOM	YES	LOCATION-EUCOM	?

Number transportable
by C-5: 2

Armament is 7.62mm.

Communications:

UHF
VHF
HF
FM

Table 3-25

RESULTS

3.3.4 The BUILD subsystem - The BUILD subsystem is used to construct a new data base or to modify an existing data base. The user is presented a menu of options as shown in Table 3-26.

```
THE FOLLOWING OPTIONS ARE AVAILABLE:

 1) LOAD A DATA BASE
 2) CREATE A NEW DATA BASE
 3) MODIFY STRUCTURE
 4) ENTER DATA
 5) SAVE A DATA BASE
 6) ENTER SYSTEM DESCRIPTIONS
 7) ERASE A DATA BASE
```

Table 3-26

BUILD SUBSYSTEM MENU OF OPTIONS

To illustrate the use of the BUILD subsystem, assume that the user wants to construct a data base of American-made sailplanes. Having selected option 2, CREATE A NEW DATA BASE, the user is asked to specify the names of the systems (in this instance, sailplanes) that will comprise the data base. That dialogue is shown in Table 3-27. Note that entry of systems stops when blanks are entered as a system name.

```
ENTER THE NUMBER OF THE DESIRED OPTION:  2
ENTER SYSTEM NAME : [AQUA GLIDR]
ENTER SYSTEM NAME : [NUGGET    ]
ENTER SYSTEM NAME : [MONARCH   ]
ENTER SYSTEM NAME : [CLOUDSTER ]
ENTER SYSTEM NAME : [EAGLET    ]
ENTER SYSTEM NAME : [          ]
```

Table 3-27

SPECIFYING SYSTEM NAMES

The user must now enter keys into the data base; that is, the distinguishing characteristics of the various systems (sailplanes). Synonyms may be specified for each key name. Table 3-28 shows the dialogue.

```
ENTER KEY NAME : [PASSENGERS      ]
ENTER SYNONYM: [P    ]

ENTER KEY NAME : [WING SPAN       ]
ENTER SYNONYM: [WS   ]

ENTER KEY NAME : [LENGTH          ]
ENTER SYNONYM: [L    ]

ENTER KEY NAME : [MAX TAKEOFF WT ]
ENTER SYNONYM: [W    ]

ENTER KEY NAME : [STALLING SPEED ]
ENTER SYNONYM: [SS   ]

ENTER KEY NAME : [SELF LAUNCHING ]
ENTER SYNONYM: [SL   ]

ENTER KEY NAME : [AVAILABILITY    ]
ENTER SYNONYM: [A    ]

ENTER KEY NAME : [                ]
```

Table 3-28

SYNONYMS FOR KEY NAMES

For each key, the data may be one of three types: numeric data, binary (YES-NO) data, or a special data type as defined by the user. The user will be asked if special data types are required; more than one special data type may be defined. In the case of the sailplane data base, a special data type (construction method) is defined, as shown in Table 3-29.

```
DO YOU WISH TO DEFINE A SPECIAL DATA TYPE?  Y

ENTER DATA TYPE NAME   :CONSTRUCTION
SPECIFY A VALID ENTRY :PLANS
SPECIFY A VALID ENTRY :KIT
SPECIFY A VALID ENTRY :PREFAB
SPECIFY A VALID ENTRY :ASSEMBLED
SPECIFY A VALID ENTRY :
```

Table 3-29

SPECIFYING A SPECIAL DATA TYPE

Next the user must identify the type of data to be associated with each key. That query is shown in Table 3-30.

```
CHOOSE THE NUMBER CORRESPONDING TO THE DATA TYPE FOR EACH KEY:

 1) NUMERIC
 2) YES OR NO
 3) CONSTRUCTION

PASSENGERS      1
WING SPAN       1
LENGTH          1
MAX TAKEOFF WT  1
STALLING SPEED  1
SELF LAUNCHING  2
AVAILABILITY    3
```

Table 3-30

ASSIGNING DATA TYPES

The user must now input the individual data elements for each sailplane as shown in Table 3-31.

```
ENTER SYSTEM NAME OR ALL :
ALL

ENTER DATA VALUES FOR AQUA GLIDR :
PASSENGERS           1
WING SPAN            16
LENGTH               14
MAX TAKEOFF WT       400
STALLING SPEED       30
SELF LAUNCHING       NO
AVAILABILITY         PLANS

ENTER DATA VALUES FOR NUGGET :
PASSENGERS           1
WING SPAN            49
LENGTH               20
MAX TAKEOFF WT       900
STALLING SPEED       39
SELF LAUNCHING       NO
AVAILABILITY         ASSEMBLED

ENTER DATA VALUES FOR MONARCH :
PASSENGERS           1
WING SPAN            39
LENGTH               12
MAX TAKEOFF WT       450
STALLING SPEED       21
SELF LAUNCHING       YES
AVAILABILITY         KIT

ENTER DATA VALUES FOR CLOUDSTER :
PASSENGERS           2
WING SPAN            58
LENGTH               26
MAX TAKEOFF WT       1650
STALLING SPEED       37
SELF LAUNCHING       YES
AVAILABILITY         ASSEMBLED

ENTER DATA VALUES FOR EAGLET:
PASSENGERS           1
WING SPAN            36
LENGTH               16
MAX TAKEOFF WT       360
STALLING SPEED       33
SELF LAUNCHING       YES
AVAILABILITY         KIT
```

Table 3-31

ENTERING DATA VALUES

By choosing menu option 6, the user may specify relevant textual data for each sailplane. A sample textual entry is shown in Table 3-32.

```
ENTER NAME OF SYSTEM : EAGLET
SYSTEM:EAGLET

 1]  This aircraft is intended for Amateur
 2] construction, and it is available in kit
 3] form.  It is a shoulder-wing monoplane, with
 4] single aluminum tube bracing struts on both
 5] sides.
 6]  Kits are available from the AmEAGLE Corp.,
 7] 841 Winslow Court, Muskegon, Michigan 49441;
 8] Telephone (616) 780-4680.
 9]
10]

   .n      - moves cursor to line n
   .s(ave) - stores rationale on disc
   .p(age) - gets next page
BE SURE TO SELECT THE 'SAVE DATA BASE' OPTION
PRIOR TO TERMINATING THE SESSION.
```

Table 3-32

SAMPLE TEXTUAL ENTRY

Finally, the user should save (store) the data base (model) just created for later use. The dialogue is shown in Table 3-33.

3.3.5 The RUN subsystem - Having constructed and stored the sailplane data base using the BUILD subsystem, the user (or any other user) may access the data by using the RUN subsystem. The first step is to load the sailplane data base, as shown in Table 3-34.

```
ENTER THE NAME OF THE MODEL:  SAILPLANES

PLEASE ENTER YOUR NAME:RMG
ENTER TODAY'S DATE:1 MARCH 80
DO YOU WISH TO ENTER DESCRIPTIONS OF THE DATA BASE? YES

 1] This data base reflects data from JANES
 2] ALL THE WORLDS AIRCRAFT 1977-1978.
 3]
 4] All of the sailplanes are U.S. designed
 5] and available from U.S. firms as either
 6] plans, kits, prefab, or assembled.
 7]
 8] A special data type indentifies their
 9] availability:  PLANS,KIT,PREFAB,ASSEMBLED.
10]

   .n      - moves cursor to line n
   .s(ave) - stores rationale on disc
   .p(age) - gets next page
```

Table 3-33

SAVING THE DATA BASE

```
THE FOLLOWING OPTIONS ARE AVAILABLE:

 1) LOAD A DATA BASE
 2) SELECT
 3) PRINT SYNONYMS
 4) PRINT RESULTS
 5) PRINT DATA

ENTER THE NUMBER OF THE DESIRED OPTION: 1
DATA BASES CURRENTLY AVAILABLE:

 1) HELO
 2) CARS
 3) SAILPLANES

ENTER THE NUMBER OF THE DESIRED OPTION: 3
DATA BASE : SAILPLANES
 This data base reflects data from JANES
 ALL THE WORLDS AIRCRAFT 1977-1978.

 All of the sailplanes are U.S. designed
 and available from U.S. firms as either
 plans, kits, prefab, or assembled.

 A special data type indentifies their
 availability: PLANS,KIT,PREFAB,ASSEMBLED.
```

Table 3-34

LOADING THE DATA BASE

Selection of key information from the sailplane data base proceeds by choosing menu option 2. Table 3-35 shows a typical retrieval procedure.

The user can examine the two sailplanes meeting the restrictions by selecting menu option 4, as shown in Table 3-36.

```
THE FOLLOWING OPTIONS ARE AVAILABLE:

 1) LOAD A DATA BASE
 2) SELECT
 3) PRINT SYNONYMS
 4) PRINT RESULTS
 5) PRINT DATA

ENTER THE NUMBER OF THE DESIRED OPTION: 2
ENTER CRITERIA :
P=1
CRITERIA : PASSENGERS=1

4 SYSTEMS MEET THIS CRITERIA.

DO YOU WISH TO SEE THE SYSTEMS? Y

 AQUA GLIDR
 NUGGET
 MONARCH
 EAGLET

PRESS EXECUTE TO CONTINUE...

DO YOU WISH TO SPECIFY ADDITIONAL CRITERIA? Y
ENTER CRITERIA :
A=KIT
CRITERIA : (PASSENGERS=1)^(AVAILABILITY=KIT)

2 SYSTEMS MEET THIS CRITERIA.

DO YOU WISH TO SEE THE SYSTEMS?  Y

 MONARCH
 EAGLET

PRESS EXECUTE TO CONTINUE...

DO YOU WISH TO SPECIFY ADDITIONAL CRITERIA? NO
```

Table 3-35

TYPICAL RETRIEVAL PROCEDURE

```
THE FOLLOWING OPTIONS ARE AVAILABLE:

 1) LOAD A DATA BASE
 2) SELECT
 3) PRINT SYNONYMS
 4) PRINT RESULTS
 5) PRINT DATA

ENTER THE NUMBER OF THE DESIRED OPTION: 4
TURN PRINTER ON & ALIGN PAPER.  PRESS EXECUTE TO CONTINUE...

AUTHOR : RMG      DATE : 1 MARCH 1980

  This data base reflects data from JANES
  ALL THE WORLDS AIRCRAFT 1977-1978.

  All of the sailplanes are U.S. designed
  and available from U.S. firms as either
  plans, kits, prefab, or assembled.

  A special data type indentifies their
  availability: PLANS,KIT,PREFAB,ASSEMBLED.

CRITERIA : (PASSENGERS=1)∧(AVAILABILITY=KIT)

MONARCH

PASSENGERS      : 1
WING SPAN       : 39
LENGTH          : 12
MAX TAKEOFF WT  : 450
STALLING SPEED  : 21
SELF LAUNCHING  : YES
AVAILABILITY    : KIT

 The Monarch is a single-seat ultra-light
glider designed and built by Jim Marske in
1974.  Both plans and kits are available to
amateur constructors.

 The fuselage is a simple minimal beam-type
structure of laminated glassfibre, moulded in
two halves and joined at the centerline.

 The cockpit is open seat with overhead control.
```

Table 3-36

SAMPLE RESULTS

EAGLET

```
PASSENGERS      : 1
WING SPAN       : 36
LENGTH          : 16
MAX TAKEOFF WT  : 360
STALLING SPEED  : 33
SELF LAUNCHING  : YES
AVAILABILITY    : KIT
```

This aircraft is intended for amateur construction, and it is available in kit form. It is a shoulder-wing monoplane, with single aluminum tube bracing struts on both sides.

Kits are available from the AmEAGLE Corp., 841 Winslow Court, Muskegon, Michigan 49441; Telephone (616) 780-4680.

Table 3-36

SAMPLE RESULTS (Continued)

3.3.6 Additional features of SELECT - In addition to the operational features of the BUILD and RUN subsystems described above, several other features are available to the user.

The user may also use the BUILD subsystem to modify an existing data base by adding or deleting systems or amending individual data items pertaining to a particular system. Modification of a data base is preformed by loading the data base to be modified and then selecting menu option 3 from the BUILD menu as shown in Table 3-37. The user may also delete an entire data base by choosing menu option 7.

The user may also use the RUN subsystem to retrieve all of the data present in the entire data base. That is done by choosing menu option 5 as listed in Table 3-38.

```
THE FOLLOWING OPTIONS ARE AVAILABLE:

 1) LOAD A DATA BASE
 2) CREATE A NEW DATA BASE
 3) MODIFY STRUCTURE
 4) ENTER DATA
 5) SAVE A DATA BASE
 6) ENTER SYSTEM DESCRIPTIONS
 7) ERASE A DATA BASE
```

Table 3-37

THE BUILD MENU

```
THE FOLLOWING OPTIONS ARE AVAILABLE:

 1) LOAD A DATA BASE
 2) SELECT
 3) PRINT SYNONYMS
 4) PRINT RESULTS
 5) PRINT DATA
```

Table 3-38

THE RUN MENU

3.4 Conclusions and Recommendations

Our experiences with the R-SCREEN decision aid in particular, and to a lesser extent with OPSEL, provide additional instances in which decision aids have been technically successful from a decision-analytic standpoint, have been acknowledged as useful by those who have tried to use them[1] and demonstrated as such in laboratory settings, and then have lapsed into disuse when no one was present to provide professional decision-analytic assistance and guidance. For some time, beginning in the later stages of the DARPA-sponsored and ONR-monitored Advanced Decision Technology (ADT) Program's field project in 1977 with the U.S. European Command (EUCOM), we had suspected that the principal determiner of this behavior was that the decision aids then in use, OPINT and EVAL,[2] provided the user with no problem-structuring assistance. Problem structuring can be thought of as the process by which the elements of the problem are mapped into the basic building blocks of decision analysis: options, events, subsequent acts, and outcome evaluation criteria. Unlike the numerical operations involved in decision analysis, which are well defined, problem structuring remains more of an art. It is perfected only after extensive training and considerable practical experience.

Because of the extensive training and experience required to make effective use of OPINT, EVAL, and other similar decision aids, it seemed reasonable to us, in

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[1] See, for example, Sage, Andrew P. and White, Chelsea C., III. Evaluation of Two DDI Decision Aids Developed for DCA:C140. Document Number 33737-W114-RU-00. Falls Church, VA: TRW Defense and Space Systems Group, January 1980.

[2] OPINT can be thought of as a precursor to OPSEL and EVAL as the intellectual parent of R-SCREEN.

retrospect, that there would be a decline in the use of these aids in the absence of a skilled decision analyst. Such a decline had been observed at EUCOM. Those who had received training had not received a sufficient amount to be confident in applying the aids to new situations that arose, and they were unable to successfully transfer what knowledge they did gain to their own successors. Thus, the aids lapsed into disuse.

The R-SCREEN aid was developed specifically to address this problem-structuring training issue. To be successful, the aid had to fill the middle ground between two classes of then existing decision aids. As Von Winterfeldt[3] points out, existing decision aids had, until R-SCREEN, represented two extremes: those that were highly specific and prestructured with data which applied to highly limited repetitive situations but required virtually no training,[4] and those which were fundamentally empty structural aids which start with no predisposition toward (or special information about) any substantive problem.[5] He goes on to observe that "neither extreme is totally satisfactory. The middle ground of problem driven but still generalizable structures and models needs to be filled." This, he adds, would be accomplished by "searching for generalizable features of problems that identify generic classes of decisions. These generic classes can then be modeled and structured by 'prototypical decision-analytic structures'."

---

[3]Von Winterfeldt, D. Structuring Decision Problems. Invited paper presented at the Seventh Research Conference on Subjective Probability, Utility, and Human Decision Making. Goteborg, Sweden, August, 1979.

[4]DDI's SURVAV decision aid.

[5]EVAL and OPINT.

The location of a useful "middle ground" represents an important trade-off. As more generality and flexibility are added to an aid, its range of application and quality of representation rise, but so do the demands placed on the user, in terms of time, training, and analytic sophistication. On the other hand, as more detail is pre-canned, the models become more concrete, easier to understand and more convincing; at the same time, they become less flexible, less manageable (because of their size), and less general in their range of application.

One tenable hypothesis as to why the R-SCREEN decision aid was not used is that its design fell outside this acceptable middle ground. We have several reasons, however, for concluding that this was most likely not the case. First, the criteria contained in the templates were initially generalized from an analysis of several hundred real crisis situations and reflect a consensus among experienced military decision makers as to what tended to most differentiate among courses of action in crisis situations. This suggests the list was sufficiently comprehensive. Second, none of the templates contained more than fourteen bottom-level criteria; this suggests that not so much data was pre-canned as to make the models inflexible. Finally, the R-SCREEN templates were constructed so that the criteria could be modified by the end-user to "fine tune" the structure as necessary to satisfy the particular needs of that user.

If indeed the appropriate balance was struck between generality and specificity, then two other hypotheses can be advanced to explain why R-SCREEN was not used. The first is that users will voluntarily employ an aid only when it provides an immediate and direct reduction in their workload. According to this hypothesis, users are far more sensitive to level of effort than to quality of results and will shy away from an aid that requires them to do different tasks

than they might normally do (though total effort may be the same), even if it results in a substantial improvement in decision quality.

An alternative hypothesis, not necessarily incompatible with the first, is that the decision aids that have been constructed and tested thus far have failed to gain acceptance because they do not adequately motivate the user.[6] According to this hypothesis, even if workload is decreased, users will avoid any aid which is inconvenient, frustrating, boring, intimidating, or time-consuming to use, while they would perhaps be willing to accept additional workload if the aid were pleasurable rather than painful to use.

We believe that this last hypothesis is the most likely explanation for what occurred in the JOD. The R-SCREEN decision aid was designed so that the judgments required of the user were similar to those which he would normally make. Although the users were required to encode numerically the outputs of this judgmental process, there was no indication either from the JOD personnel or from the ICAF subjects that this was either difficult or unnatural for them. On the other hand, there were numerous comments made which suggest that the users found the man-machine relations aspect of the aid deficient. Several did not type at all or did not type well; they found entering their judgments by typing to be time-consuming, frustrating, and responsible for a loss of continuity of thought.

One of the major goals for R-SCREEN was to provide a framework which would encourage creative decision problem

---

[6]User motivation is a function of a number of factors of which man-machine relations is one. While we believe that this was a strong determiner of performance in this case, we believe that other factors beyond our control were also of significance.

solving. However, user comments suggest that we failed in retrospect to allow sufficient conversational interaction with the framework, so that rather than encouraging spontaneity of thought, we forced people into a "think first, enter data later" mode of operation which discouraged creativity. Most creative problem solving is characterized by false starts and the interruption of one activity to do something else. The way R-SCREEN is designed, the user must do things in a prescribed order. If, for example, in entering data at one place in the structure the user should get an insight with respect to another part of the structure, it is impossible to jump to that location and act on that insight; the user must write it down and later use an EDIT function to make the appropriate change. Similarly, one cannot scroll to a portion of the display in a natural way to correct an error. Finally, there is no easy way to stop the program in "mid-stream" when interrupted, store the partial structure, and return to the stopping point at a later time. Users also commented that the display or feedback of intermediate results would have helped them determine if they were doing things correctly.

In light of these and other first-hand observations, we recommend that a second-generation R-SCREEN aid be developed which retains the analytical underpinnings of the current aid but which incorporates a high degree of user engineering to make the aid more pleasurable to use and to encourage creative problem solving. Specific design objectives include:

(1) simplified data entry, perhaps using graphical utility scales in conjunction with a touch screen for data input;

(2) direct accessibility of a graphical display, particularly a bright, multi-colored one which can be

used to display structure, intermediate and final results, and sensitivity analyses;

(3) audible response to provide feedback as inputs are received and events occur and to reinforce the user for successful performance; and

(4) a totally re-entrant program which allows the user to skip from place to place in the structure as ideas occur, which permits full-screen editing, and which allows the user to stop the program at any point and return to that point when circumstances permit.

We believe that if a decision aid can be configured to incorporate these principles, voluntary usage can be maintained while improving the quality of decisions. If this hypothesis is incorrect and a highly successful user-engineering effort proves inadequate to generate continued user acceptance, a reasonable conclusion would be to abandon the notion of general-purpose decision aiding in favor of more modest special-purpose aids which reduce workload on the more routine tasks. In such tasks, the quality of decisions is less critical than the sheer volume of drudgery to be performed or the amount of information to be processed.

4.0 DECISION ANALYSIS STUDIES

Five decision analysis studies of real decision problems were conducted during the course of the contract. One of them, an in-depth crisis decision analysis performed with members of the J-5 Directorate of the Joint Chiefs of Staff, is discussed at length in the following section. That discussion is followed by summary descriptions of the other four decision analysis studies, all of which addressed live decision problems encountered during the course of the contract by the contract sponsor, DCA.

4.1 The El Salvador Problem

This section describes the application of decision analysis to an illustrative contingency planning and analysis problem. In the example, two potentially useful methodologies are examined; one involves the formulation of a typical decision tree structure and the other utilizes an influence or probability diagram. The decision tree structure uses a DDI software module referred to as TREE, and the probability diagram uses DDI software known as OPINT (Operations/Intelligence).

Both programs (TREE and OPINT) operate on an IBM 5110 computer and are highly interactive so that the analyst-member of the contingency planning staff can formulate the structure to fit their own particular problem. The program can be used by an individual who is a programmer and who has not had previous experience operating computers. It is recommended that the analyst create the structure of the problem using pencil and paper before making inputs and creating the model on the computer. During the course of building a model on the computer, worksheets can be printed which are helpful in making the probability assessments and

value judgments to be used as inputs. Sample worksheets from TREE are displayed in Table 4-1.

The decision tree version of the El Salvador problem is displayed in Figure 4-1. In this figure, one of the paths through the tree begins with a decision to provide military assistance in the form of U.S. advisory personnel, equipment, and munitions. If it is assumed that the prior probability of an insurrection in El Salvador is .6 or greater, it can be seen that providing military assistance is estimated to reduce the probability from .6 to .3. By tracing the top branch, which assumes there is an insurrection, three possible courses of action are available: direct U.S. (unilateral) military action, military action taken jointly with other Latin American nations, and military action taken by a third country with U.S. support. The consequences of these actions form the end-points of the tree and consist of the following:

- o restores the old or previous government which is essentially unchanged in character and outlook;
- o restores the previous government which is improved by the introduction of new leaders and reforms; and
- o the action taken fails to achieve its objective and a radically new government takes over the country.

The relative attractiveness of these outcomes, given each of the courses of action, is then measured across six criteria and used as data for the model. (See the columns along the right side of Figure 4-1.) The attractiveness of each is specified in the form of a subjective assessment made on a 0-100 scale and weighted according to the relative

```
1 1  -DECISION  -MIL ASSIST
 1) INSURR         ----
 2) NO INSURR      ----


1 1 1 1  -DECISION  -MIL ASSIST-INSURR    -MIL ACTION
 1) OLD GOVT       ----
 2) NEW GOVT       ----


1 1 1 1 1  -MIL ASSIST-INSURR    -MIL ACTION-OLD GOVT
 1) UNCHNGED       ----
 2) IMPROVED       ----


1 1 1 2  -DECISION  -MIL ASSIST-INSURR    -MULTI-NAT
 1) OLD GOVT       ----
 2) NEW GOVT       ----


1 1 1 2 1  -MIL ASSIST-INSURR    -MULTI-NAT -OLD GOVT
 1) UNCHNGED       ----
 2) IMPROVED       ----


1 1 1 3  -DECISION  -MIL ASSIST-INSURR    -3RD NAT
 1) OLD GOVT       ----
 2) NEW GOVT       ----


1 1 1 3 1  -MIL ASSIST-INSURR    -3RD NAT   -OLD GOVT
 1) UNCHNGED       ----
 2) IMPROVED       ----


1 1 2  -DECISION  -MIL ASSIST-NO INSURR
 1) UNCHNGED       ----
 2) IMPROVED       ----
```

Table 4-1

SAMPLE WORKSHEETS FOR TREE

```
1 2  -DECISION  -DIP PRESS
 1) INSURR          ____
 2) NO INSURR       ____


1 2 1 1  -DECISION  -DIP PRESS -INSURR    -DIRECT MIL
 1) OLD GOVT        ____
 2) NEW GOVT        ____


1 2 1 1 1  -DIP PRESS -INSURR    -DIRECT MIL-OLD GOVT
 1) UNCHNGED        ____
 2) IMPROVED        ____


1 2 1 2  -DECISION  -DIP PRESS -INSURR    -MULTI-NAT
 1) OLD GOVT        ____
 2) NEW GOVT        ____


1 2 1 2 1  -DIP PRESS -INSURR    -MULTI-NAT -OLD GOVT
 1) UNCHNGED        ____
 2) IMPROVED        ____


1 2 1 3  -DECISION  -DIP PRESS -INSURR    -3RD NAT
 1) OLD GOVT        ____
 2) NEW GOVT        ____


1 2 1 3 1  -DIP PRESS -INSURR    -3RD NAT   -OLD GOVT
 1) UNCHNGED        ____
 2) IMPROVED        ____


1 2 2  -DECISION  -DIP PRESS -NO INSURR
 1) UNCHNGED        ____
 2) IMPROVED        ____
```

Table 4-1

SAMPLE WORKSHEETS FOR TREE (Continued)

```
1 3  -DECISION  -PRESS SAL
 1) INSURR        ----
 2) NO INSURR     ----

1 3 1 1  -DECISION  -PRESS SAL -INSURR    -DIRECT MIL
 1) OLD GOVT      ----
 2) NEW GOVT      ----

1 3 1 1 1  -PRESS SAL -INSURR    -DIRECT MIL-OLD GOVT
 1) UNCHNGED      ----
 2) IMPROVED      ----

1 3 1 2  -DECISION  -PRESS SAL -INSURR    -MULTI-NAT
 1) OLD GOVT      ----
 2) NEW GOVT      ----

1 3 1 2 1  -PRESS SAL -INSURR    -MULTI-NAT -OLD GOVT
 1) UNCHNGED      ----
 2) IMPROVED      ----

1 3 1 3  -DECISION  -PRESS SAL -INSURR    -3RD NAT
 1) OLD GOVT      ----
 2) NEW GOVT      ----

1 3 1 3 1  -PRESS SAL -INSURR    -3RD NAT   -OLD GOVT
 1) UNCHNGED      ----
 2) IMPROVED      ----

1 3 2  -DECISION  -PRESS SAL -NO INSURR
 1) UNCHNGED      ----
 2) IMPROVED      ----
```

Table 4-1

SAMPLE WORKSHEETS FOR TREE (Continued)

	USDOM	STAB	LATAM	PROUS	A-DOM	RIG
HT						
1 DECISION						
1 1 MIL ASSIST						
1 1 1 INSURR						
1 1 1 1 MIL ACTION						
1 1 1 1 1 OLD GOVT						
1 1 1 1 1 1 UNCHNGED	_____	_____	_____	_____	_____	__
1 1 1 1 1 2 IMPROVED	_____	_____	_____	_____	_____	__
1 1 1 1 2 NEW GOVT	_____	_____	_____	_____	_____	__
1 1 1 2 MULTI-NAT						
1 1 1 2 1 OLD GOVT						
1 1 1 2 1 1 UNCHNGED	_____	_____	_____	_____	_____	__
1 1 1 2 1 2 IMPROVED	_____	_____	_____	_____	_____	__
1 1 1 2 2 NEW GOVT	_____	_____	_____	_____	_____	__
1 1 1 3 3RD NAT						
1 1 1 3 1 OLD GOVT						
1 1 1 3 1 1 UNCHNGED	_____	_____	_____	_____	_____	__
1 1 1 3 1 2 IMPROVED	_____	_____	_____	_____	_____	__
1 1 1 3 2 NEW GOVT	_____	_____	_____	_____	_____	__
1 1 2 NO INSURR						
1 1 2 1 UNCHNGED	_____	_____	_____	_____	_____	__
1 1 2 2 IMPROVED	_____	_____	_____	_____	_____	__
1 2 DIP PRESS						
1 2 1 INSURR						
1 2 1 1 DIRECT MIL						
1 2 1 1 1 OLD GOVT						
1 2 1 1 1 1 UNCHNGED	_____	_____	_____	_____	_____	__
1 2 1 1 1 2 IMPROVED	_____	_____	_____	_____	_____	__
1 2 1 1 2 NEW GOVT	_____	_____	_____	_____	_____	__

Table 4-1

SAMPLE WORKSHEETS FOR TREE (Continued)

1 2 1 2 MULTI-NAT						
1 2 1 2 1 OLD GOVT						
1 2 1 2 1 1 UNCHNGED	____	____	____	____	____	__
1 2 1 2 1 2 IMPROVED	____	____	____	____	____	__
1 2 1 2 2 NEW GOVT	____	____	____	____	____	__
1 2 1 3 3RD NAT						
1 2 1 3 1 OLD GOVT						
1 2 1 3 1 1 UNCHNGED	____	____	____	____	____	__
1 2 1 3 1 2 IMPROVED	____	____	____	____	____	__
1 2 1 3 2 NEW GOVT	____	____	____	____	____	__
1 2 2 NO INSURR						
1 2 2 1 UNCHNGED	____	____	____	____	____	__
1 2 2 2 IMPROVED	____	____	____	____	____	__
1 3 PRESS SAL						
1 3 1 INSURR						
1 3 1 1 DIRECT MIL						
1 3 1 1 1 OLD GOVT						
1 3 1 1 1 1 UNCHNGED	____	____	____	____	____	__
1 3 1 1 1 2 IMPROVED	____	____	____	____	____	__
1 3 1 1 2 NEW GOVT	____	____	____	____	____	__
1 3 1 2 MULTI-NAT						
1 3 1 2 1 OLD GOVT						
1 3 1 2 1 1 UNCHNGED	____	____	____	____	____	__
1 3 1 2 1 2 IMPROVED	____	____	____	____	____	__
1 3 1 2 2 NEW GOVT	____	____	____	____	____	__
1 3 1 3 3RD NAT						
1 3 1 3 1 OLD GOVT						
1 3 1 3 1 1 UNCHNGED	____	____	____	____	____	__
1 3 1 3 1 2 IMPROVED	____	____	____	____	____	__
1 3 1 3 2 NEW GOVT	____	____	____	____	____	__
1 3 2 NO INSURR						
1 3 2 1 UNCHNGED	____	____	____	____	____	__
1 3 2 2 IMPROVED	____	____	____	____	____	__

Table 4-1

SAMPLE WORKSHEETS FOR TREE (Continued)

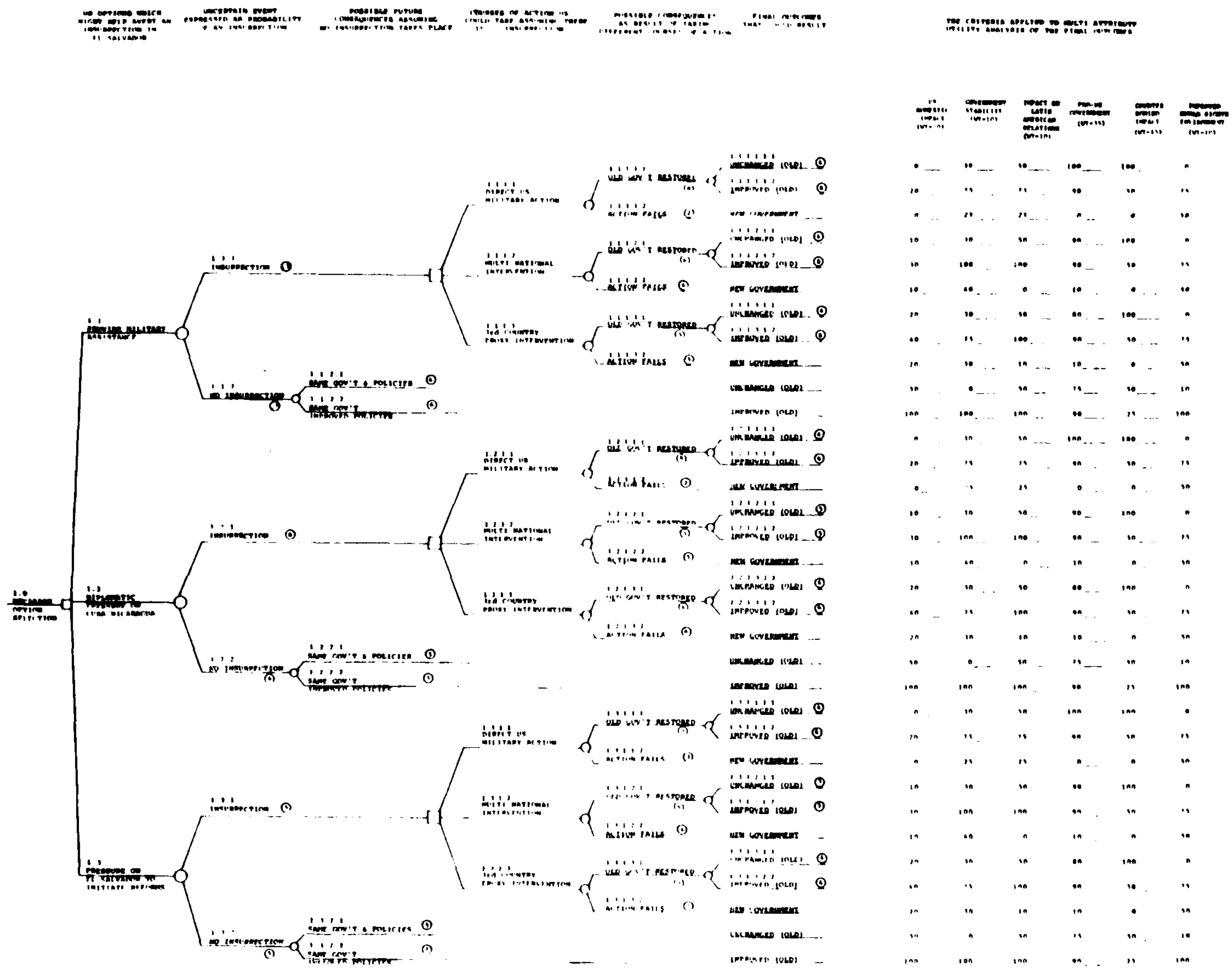

Figure 4-1

EL SALVADOR DECISION TREE

importance of each criterion. Finally, these assessments are combined and folded back to yield the expected value for each course of action or decision option.

In the example, the criteria are:

- o the impact of the course of action taken and the outcome on U.S. domestic policy as reflected by Congress, the media, and public opinion;

- o the extent to which the new government of El Salvador will remain viable and stable;

- o impact of the course of action taken and the final outcome on U.S.-Latin American relations;

- o the extent to which the new government will be pro-U.S. in character and outlook;

- o whether the formation of the government of El Salvador will encourage or discourage revolutionary activities in other Latin American countries; and

- o whether the government of El Salvador will provide a constructive human rights environment as advocated by the U.S.

An example of the results obtained with the program using illustrative assessments is contained in Table 4-2. (If the assessments had been provided by Latin American specialists, the results would almost certainly be quite different.)

In this example, the expected utility of providing military assistance to El Salvador is the least attractive option: pressuring El Salvador (the Romera government) to

1 -DECISION [D]

	CRIT. WEIGHTS:	35	5	5	20	10	25	
	BRANCH	USDOM	STAB	LATAM	PROUS	A-DOM	RIGHT	TOTAL
1)	MIL ASSIST	45	26	59	77	48	33	49
2)	DIP PRESS	40	53	68	79	47	57	55
3)	PRESS SAL	49	59	71	76	39	64	59

ENTER NODE NUMBER:

Table 4-2

ILLUSTRATIVE OUTPUT

initiate a reform program is most attractive, with an overall utility score of 59; and placing diplomatic pressure on Cuba and Nicaragua is the second best option.

The probabilities of insurrection versus no insurrection must reach almost 30/70 before PROVIDE MILITARY ASSISTANCE becomes more attractive than the other options--DIPLOMATIC PRESSURE ON CUBA AND NICARAGUA and PRESSURE ON EL SALVADOR TO INITIATE REFORMS. When the probability of insurrection for all options is changed to 50/50, it then becomes necessary to reduce the importance weight given to "impact of the U.S. action on domestic policy" simultaneously in order for military assistance to become the most attractive option.

The influence diagram or probability structure which is normally used in combination with the payoff matrix in the OPINT software was also applied to the El Salvador problem. (Again, it should be noted that the structure, as well as the results obtained, would be quite different if Latin American specialists had been used to formulate the problem.) The illustrative influence diagram or probability structure is outlined in Figure 4-2 and was formulated to display the

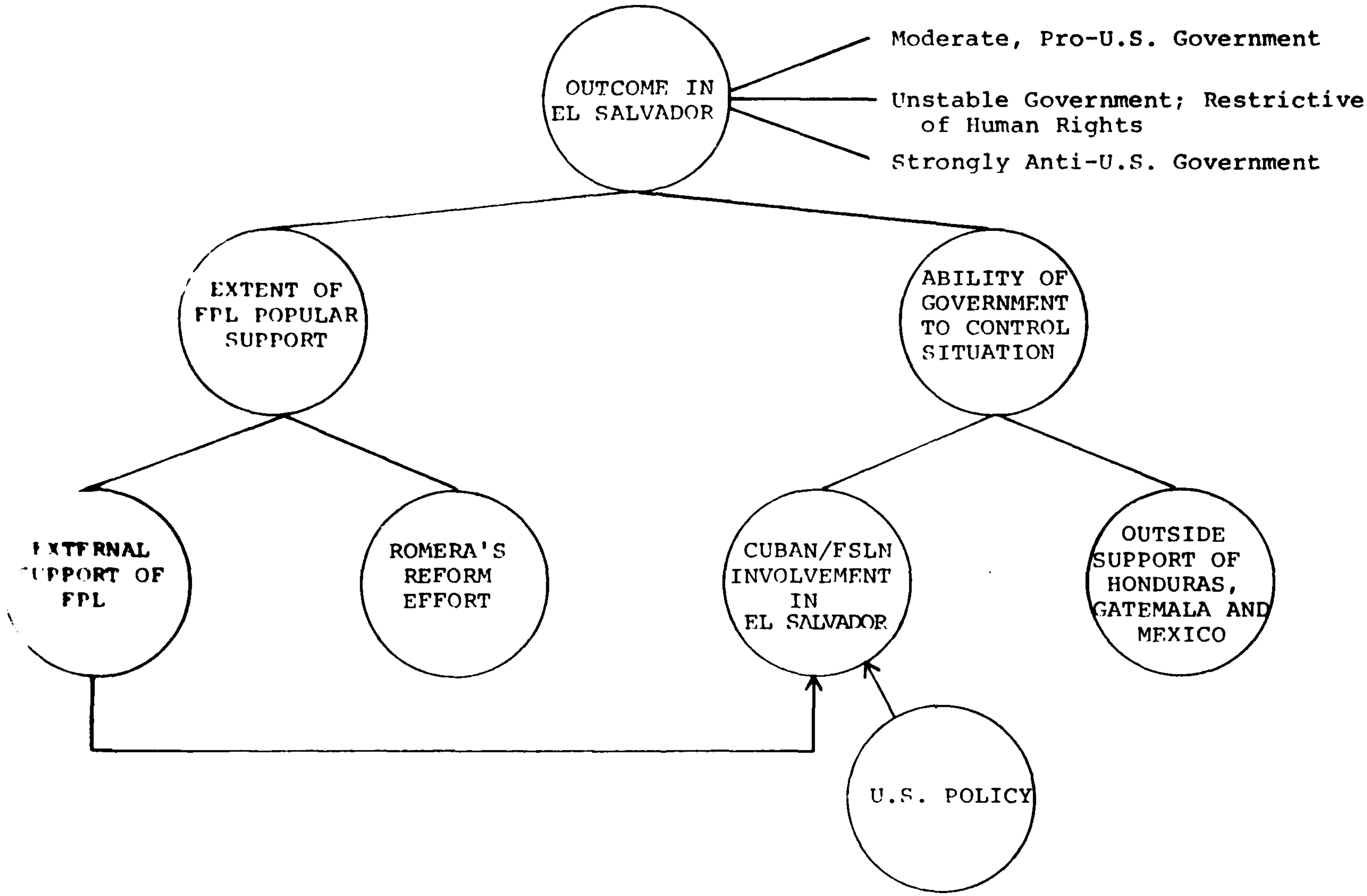

Figure 4-2
ILLUSTRATIVE INFLUENCE DIAGRAM

linkages among the major elements of the El Salvador problem. The structure was used to derive a probability distribution across three possible outcomes: a moderate, pro-U.S. government in El Salvador; an unstable government restrictive of human rights; and a strongly anti-U.S. government in El Salvador. An example of the logic underlying the structure (Figure 4-2) is that what happens to the government in El Salvador will depend in part on the ability of the present government to control the internal situation, which, in turn, depends upon the extent and nature of Cuban/FSLN involvement in El Salvador and the extent to which support is received from such allies and neighbors as Honduras, Guatemala, and Mexico. Figure 4-2 indicates that U.S. policy toward the current government will also affect the amount of Cuban/FSLN involvement.

The value of the model lies in the decomposition process, which literally forces the analysts to apply their expertise in areas where they are confident of their judgments. Referring to Figure 4-2, it can be seen that popular support of the FPL will depend in part on Romera's reform effort. In the analysis, a country expert is asked for the probability that the reform effort will be highly credible versus a program of questionable value versus a program that is not credible or will not be successful. A copy of a portion of the printout (Figure 4-3) reveals the assessment or input made by the user-analyst: a .6 probability that the reform program will b nighly credible, a .2 probability that it will be of questionable value, and .2 that it will not be credible. Table 4-3 shows the step-by-step process by which each conditional assessment for each node is calculated to achieve the final results. All of the assessments to be included in the calculations and the final probability distribution across the three possible outcomes are contained in Table 4-4. Based upon the inputs made by DDI personnel

```
            |ROMERAS REF|
             -----↑-----
                  |
      ↑---------------------↑
      |                     |
 ------|------          ------|------
|             |        |             |
```

PRESS EXECUTE TO CONTINUE

PRESS EXECUTE TO CONTINUE

LIKELIHOODS FOR EVENT ROMERAS REF

	HIGH	QUEST	NOT C
	60	20	20
MARGINAL PROB.	60	20	20

Figure 4-3

USER-ANALYST ASSESSMENT

EL SALVADOR

1 -DECISION [D]

	BRANCH	USDOM	STAB	LATAM	PROUS	A-DOM	RIGHT	TOTAL
	CRIT. WEIGHTS:	35	5	5	20	10	25	
1)	MIL ASSIST	45	26	59	77	48	33	49
2)	DIP PRESS	40	53	68	79	47	57	55
3)	PRESS SAL ←	49	59	71	76	39	64	59

1 1 -DECISION -MIL ASSIST [P]

	BRANCH / JOINT	PR	USDOM	STAB	LATAM	PROUS	A-DOM	RIGHT	TOTAL	
	CRIT. WEIGHTS:		35	5	5	20	10	25		
1)	INSURR 30.00%	(30)	10	41	57	75	56	46	40	
2)	NO INSURR 70.00%	(70)	60	20	60	78	45	28	52	
	EXPECTED VALUE		45	26	59	77	48	33	49	100.00%

1 1 1 -DECISION -MIL ASSIST-INSURR [D]

	BRANCH	USDOM	STAB	LATAM	PROUS	A-DOM	RIGHT	TOTAL
	CRIT. WEIGHTS:	35	5	5	20	10	25	
1)	MIL ACTION ←	10	41	57	75	56	46	40
2)	MULTI-NAT	17	52	48	58	42	47	39
3)	3RD NAT	26	37	15	48	35	47	37

1 1 1 1 -DECISION -MIL ASSIST-INSURR -MIL ACTION [P]

	BRANCH / JOINT	PR	USDOM	STAB	LATAM	PROUS	A-DOM	RIGHT	TOTAL	
	CRIT. WEIGHTS:		35	5	5	20	10	25		
1)	OLD GOVT 24.00%	(80)	12	45	65	94	70	45	47	
2)	NEW GOVT 6.00%	*(20)	0	25	25	0	0	50	15	
	EXPECTED VALUE		10	41	57	75	56	46	40	30.00%

Table 4-3

MATRIX DISPLAY

1 1 1 1 1 -MIL ASSIST-INSURR -MIL ACTION-OLD GOVT [P]

BRANCH	PR	USDOM	STAB	LATAM	PROUS	A-DOM	RIGHT	TOTAL	
CRIT. WEIGHTS:		35	5	5	20	10	25		
JOINT									
1) UNCHNGED 9.60%	*(40)	0	0	50	100	100	0	32	
2) IMPROVED 14.40%	*(60)	20	75	75	90	50	75	56	
EXPECTED VALUE		12	45	65	94	70	45	47	24.00%

1 1 1 2 -DECISION -MIL ASSIST-INSURR -MULTI-NAT [P]

BRANCH	PR	USDOM	STAB	LATAM	PROUS	A-DOM	RIGHT	TOTAL	
CRIT. WEIGHTS:		35	5	5	20	10	25		
JOINT									
1) OLD GOVT 18.00%	(60)	22	60	80	90	70	45	51	
2) NEW GOVT 12.00%	*(40)	10	40	0	10	0	50	20	
EXPECTED VALUE		17	52	48	58	42	47	39	30.00%

1 1 1 2 1 -MIL ASSIST-INSURR -MULTI-NAT -OLD GOVT [P]

BRANCH	PR	USDOM	STAB	LATAM	PROUS	A-DOM	RIGHT	TOTAL	
CRIT. WEIGHTS:		35	5	5	20	10	25		
JOINT									
1) UNCHNGED 7.20%	*(40)	10	0	50	90	100	0	34	
2) IMPROVED 10.80%	*(60)	30	100	100	90	50	75	62	
EXPECTED VALUE		22	60	80	90	70	45	51	18.00%

1 1 1 3 -DECISION -MIL ASSIST-INSURR -3RD NAT [P]

BRANCH	PR	USDOM	STAB	LATAM	PROUS	A-DOM	RIGHT	TOTAL	
CRIT. WEIGHTS:		35	5	5	20	10	25		
JOINT									
1) OLD GOVT 15.00%	(50)	32	45	20	86	70	45	50	
2) NEW GOVT 15.00%	*(50)	20	30	10	10	0	50	23	
EXPECTED VALUE		26	37	15	48	35	47	37	30.00%

Table 4-3

MATRIX DISPLAY (Continued)

1 1 1 3 1 -MIL ASSIST-INSURR -3RD NAT -OLD GOVT [P]

	PR	USDOM	STAB	LATAM	PROUS	A-DOM	RIGHT	TOTAL	
CRIT. WEIGHTS:		35	5	5	20	10	25		
BRANCH JOINT									
1) UNCHNGED 6.00%	*(40)	20	0	50	80	100	0	35	
2) IMPROVED 9.00%	*(60)	40	75	0	90	50	75	59	
EXPECTED VALUE		32	45	20	86	70	45	50	15.00%

1 1 2 -DECISION -MIL ASSIST-NO INSURR [P]

	PR	USDOM	STAB	LATAM	PROUS	A-DOM	RIGHT	TOTAL	
CRIT. WEIGHTS:		35	5	5	20	10	25		
BRANCH JOINT									
1) UNCHNGED 56.00%	*(80)	50	0	50	75	50	10	42	
2) IMPROVED 14.00%	*(20)	100	100	100	90	25	100	90	
EXPECTED VALUE		60	20	60	78	45	28	52	70.00%

1 2 -DECISION -DIP PRESS [P]

	PR	USDOM	STAB	LATAM	PROUS	A-DOM	RIGHT	TOTAL	
CRIT. WEIGHTS:		35	5	5	20	10	25		
BRANCH JOINT									
1) INSURR 60.00%	(60)	10	41	57	75	56	46	40	
2) NO INSURR 40.00%	(40)	85	70	85	85	32	73	76	
EXPECTED VALUE		40	53	68	79	47	57	55	100.00%

1 2 1 -DECISION -DIP PRESS -INSURR [D]

	USDOM	STAB	LATAM	PROUS	A-DOM	RIGHT	TOTAL
CRIT. WEIGHTS:	35	5	5	20	10	25	
BRANCH							
1) DIRECT MIL ←	10	41	57	75	56	46	40
2) MULTI-NAT	16	46	45	58	45	42	37
3) 3RD NAT	25	36	38	40	28	48	35

Table 4-3

MATRIX DISPLAY (Continued)

```
1 2 1 1 -DECISION  -DIP PRESS -INSURR    -DIRECT MIL [P]
   CRIT. WEIGHTS:        35      5      5     20     10     25
   BRANCH          PR  USDOM   STAB LATAM PROUS A-DOM RIGHT TOTAL
       JOINT
 1) OLD GOVT     ( 80)    12     45     65     94     70     45     47
      48.00%
 2) NEW GOVT    *( 20)     0     25     25      0      0     50     15
      12.00%
   EXPECTED VALUE         10     41     57     75     56     46     40  60.00%


1 2 1 1 1 -DIP PRESS -INSURR    -DIRECT MIL-OLD GOVT    [P]
   CRIT. WEIGHTS:        35      5      5     20     10     25
   BRANCH          PR  USDOM   STAB LATAM PROUS A-DOM RIGHT TOTAL
       JOINT
 1) UNCHNGED    *( 40)     0      0     50    100    100      0     32
      19.20%
 2) IMPROVED    *( 60)    20     75     75     90     50     75     56
      28.80%
   EXPECTED VALUE         12     45     65     94     70     45     47  48.00%


1 2 1 2 -DECISION  -DIP PRESS -INSURR    -MULTI-NAT  [P]
   CRIT. WEIGHTS:        35      5      5     20     10     25
   BRANCH          PR  USDOM   STAB LATAM PROUS A-DOM RIGHT TOTAL
       JOINT
 1) OLD GOVT     ( 60)    20     50     75     90     75     38     48
      36.00%
 2) NEW GOVT    *( 40)    10     40      0     10      0     50     20
      24.00%
   EXPECTED VALUE         16     46     45     58     45     42     37  60.00%


1 2 1 2 1 -DIP PRESS -INSURR    -MULTI-NAT -OLD GOVT    [P]
   CRIT. WEIGHTS:        35      5      5     20     10     25
   BRANCH          PR  USDOM   STAB LATAM PROUS A-DOM RIGHT TOTAL
       JOINT
 1) UNCHNGED    *( 50)    10      0     50     90    100      0     34
      18.00%
 2) IMPROVED    *( 50)    30    100    100     90     50     75     62
      18.00%
   EXPECTED VALUE         20     50     75     90     75     38     48  36.00%
```

Table 4-3

MATRIX DISPLAY (Continued)

1 2 1 3 -DECISION -DIP PRESS -INSURR -3RD NAT [P]

BRANCH / JOINT	PR	USDOM	STAB	LATAM	PROUS	A-DOM	RIGHT	TOTAL	
CRIT. WEIGHTS:		35	5	5	20	10	25		
1) OLD GOVT 24.00%	(40)	32	45	80	86	70	45	53	
2) NEW GOVT 36.00%	*(60)	20	30	10	10	0	50	23	
EXPECTED VALUE		25	36	38	40	28	48	35	60.00%

1 2 1 3 1 -DIP PRESS -INSURR -3RD NAT -OLD GOVT [P]

BRANCH / JOINT	PR	USDOM	STAB	LATAM	PROUS	A-DOM	RIGHT	TOTAL	
CRIT. WEIGHTS:		35	5	5	20	10	25		
1) UNCHNGED 9.60%	*(40)	20	0	50	80	100	0	35	
2) IMPROVED 14.40%	*(60)	40	75	100	90	50	75	64	
EXPECTED VALUE		32	45	80	86	70	45	53	24.00%

1 2 2 -DECISION -DIP PRESS -NO INSURR [P]

BRANCH / JOINT	PR	USDOM	STAB	LATAM	PROUS	A-DOM	RIGHT	TOTAL	
CRIT. WEIGHTS:		35	5	5	20	10	25		
1) UNCHNGED 12.00%	*(30)	50	0	50	75	50	10	42	
2) IMPROVED 28.00%	*(70)	100	100	100	90	25	100	90	
EXPECTED VALUE		85	70	85	[illegible]	[illegible]	[illegible]	[illegible]	40.00%

1 3 -DECISION -PRESS SAL [P]

BRANCH / JOINT	PR	USDOM	STAB	LATAM	PROUS	A-DOM	RIGHT	TOTAL	
CRIT. WEIGHTS:		35	5	5	20	10	25		
1) INSURR 50.00%	(50)	8	39	53	66	49	46	37	
2) NO INSURR 50.00%	(50)	90	80	90	87	30	82	81	
EXPECTED VALUE		49	59	71	76	39	64	59	100.00%

Table 4-3

MATRIX DISPLAY (Continued)

```
1 3 1 -DECISION   -PRESS SAL -INSURR      [D]
    CRIT. WEIGHTS:          35      5      5     20     10     25
    BRANCH               USDOM   STAB LATAM  PROUS  A-DOM  RIGHT  TOTAL
 1) DIRECT MIL               8     39     53     66     49     46     37
      ←
 2) MULTI-NAT               16     46     45     58     45     42     37

 3) 3RD NAT                 25     36     38     40     28     48     35


1 3 1 1 -DECISION   -PRESS SAL -INSURR     -DIRECT MIL [P]
    CRIT. WEIGHTS:          35      5      5     20     10     25
    BRANCH          PR   USDOM   STAB LATAM  PROUS  A-DOM  RIGHT  TOTAL
         JOINT
 1) OLD GOVT      ( 70)     12     45     65     94     70     45     47
      35.00%
 2) NEW GOVT     *( 30)      0     25     25      0      0     50     15
      15.00%
    EXPECTED VALUE           8     39     53     66     49     46     37  50.00%


1 3 1 1 1 -PRESS SAL -INSURR     -DIRECT MIL-OLD GOVT    [P]
    CRIT. WEIGHTS:          35      5      5     20     10     25
    BRANCH          PR   USDOM   STAB LATAM  PROUS  A-DOM  RIGHT  TOTAL
         JOINT
 1) UNCHNGED     *( 40)      0      0     50    100    100      0     32
      14.00%
 2) IMPROVED     *( 60)     20     75     75     90     50     75     56
      21.00%
    EXPECTED VALUE          12     45     65     94     70     45     47  35.00%


1 3 1 2 -DECISION   -PRESS SAL -INSURR     -MULTI-NAT  [P]
    CRIT. WEIGHTS:          35      5      5     20     10     25
    BRANCH          PR   USDOM   STAB LATAM  PROUS  A-DOM  RIGHT  TOTAL
         JOINT
 1) OLD GOVT      ( 60)     20     50     75     90     75     38     48
      30.00%
 2) NEW GOVT     *( 40)     10     40      0     10      0     50     20
      20.00%
    EXPECTED VALUE          16     46     45     58     45     42     37  50.00%
```

Table 4-3

MATRIX DISPLAY (Continued)

```
1 3 1 2 1 -PRESS SAL -INSURR     -MULTI-NAT -OLD GOVT    [P]
    CRIT. WEIGHTS:         35     5     5    20    10    25
    BRANCH          PR  USDOM  STAB LATAM PROUS A-DOM RIGHT TOTAL
       JOINT
 1) UNCHNGED     *( 50)    10     0    50    90   100     0    34
      15.00%
 2) IMPROVED     *( 50)    30   100   100    90    50    75    62
      15.00%
    EXPECTED VALUE         20    50    75    90    75    38    48   30.00%


1 3 1 3 -DECISION  -PRESS SAL -INSURR     -3RD NAT     [P]
    CRIT. WEIGHTS:         35     5     5    20    10    25
    BRANCH          PR  USDOM  STAB LATAM PROUS A-DOM RIGHT TOTAL
       JOINT
 1) OLD GOVT      ( 40)    32    45    80    86    70    45    53
      20.00%
 2) NEW GOVT     *( 60)    20    30    10    10     0    50    23
      30.00%
    EXPECTED VALUE         25    36    38    40    28    48    35   50.00%


1 3 1 3 1 -PRESS SAL -INSURR     -3RD NAT    -OLD GOVT    [P]
    CRIT. WEIGHTS:         35     5     5    20    10    25
    BRANCH          PR  USDOM  STAB LATAM PROUS A-DOM RIGHT TOTAL
       JOINT
 1) UNCHNGED     *( 40)    20     0    50    80   100     0    35
       8.00%
 2) IMPROVED     *( 60)    40    75   100    90    50    75    64
      12.00%
    EXPECTED VALUE         32    45    80    86    70    45    53   20.00%


1 3 2 -DECISION  -PRESS SAL -NO INSURR  [P]
    CRIT. WEIGHTS:         35     5     5    20    10    25
    BRANCH          PR  USDOM  STAB LATAM PROUS A-DOM RIGHT TOTAL
       JOINT
 1) UNCHNGED     *( 20)    50     0    50    75    50    10    42
      10.00%
 2) IMPROVED     *( 80)   100   100   100    90    25   100    90
      40.00%
    EXPECTED VALUE         90    80    90    87    30    82    81   50.00%

TURN THE PRINTER OFF
```

Table 4-3

MATRIX DISPLAY (Continued)

```
          |SALVADOR    |
           ------↑-----
                 |
        ↑----------------↑
        |                |
|FPL SUPPORT|     |GOVT CONTRL|
```

PRESS EXECUTE TO CONTINUE

PRESS EXECUTE TO CONTINUE

LIKELIHOODS FOR EVENT SALVADOR GIVEN THE FOLLOWING OUTCOMES
OF EVENTS FPL SUPPORT AND GOVT CONTR

	PROUS	RESTR	ANTI
WIDE |GOOD (10)	15	10	75
ISOLT|GOOD (14)	20	40	40
AL NO|GOOD (25)	10	30	60
WIDE |SECRT(7)	55	20	25
ISOLT|SECRT(9)	25	30	45
AL NO|SECRT(16)	15	35	50
WIDE |TENUS(4)	90	10	0
ISOLT|TENUS(6)	45	20	35
AL NO|TENUS(10)	20	60	20
MARGINAL PROB.	45	24	31

Table 4-4

FINAL PROBABILITIES FOR ALL SCENARIOS

```
      (GOVT CONTRL)
      ------↑------
            |
            |
 ↑----------------↑
 |                |
-------------  ------------
(CUBA/FSLN  )  (OUTSIDE SUP)
```

PRESS EXECUTE TO CONTINUE

PRESS EXECUTE TO CONTINUE

LIKELIHOODS FOR EVENT GOVT CONTRLGIVEN THE FOLLOWING OUTCOMES
OF EVENTS CUBA/FSLN AND OUTSIDE SU

	GOOD	SECRT	TENUS
BOTH (ALL 3(10)	45	35	20
ONE C(ALL 3(11)	40	35	25
NO PR(ALL 3(9)	15	25	60
BOTH (PARTL(20)	65	25	10
ONE C(PARTL(21)	50	35	15
NO PR(PARTL(18)	20	30	50
BOTH (NO SP(3)	80	15	5
ONE C(NO SP(4)	50	35	15
NO PR(NO SP(3)	35	35	30
MARGINAL PROB.	49	32	19

Table 4-4

FINAL PROBABILITIES FOR ALL SCENARIOS (Continued)

```
                |OUTSIDE SUP|
                 -----↑-----
                      |
            ↑---------------------↑
            |                     |
      ------|------         ------|------
      |           |         |           |

      PRESS EXECUTE TO CONTINUE

      PRESS EXECUTE TO CONTINUE




      LIKELIHOODS FOR EVENT OUTSIDE SUP

                           ALL 3  PARTL  NO SP
                             30     60     10
      MARGINAL PROB.         30     60     10
```

Table 4-4

FINAL PROBABILITIES FOR ALL SCENARIOS (Continued)

```
|CUBA/FSLN  |
------↑------
      |
↑-------------------↑
|                   |
|EXT SUPPORT|   |U S POLICY |
```

PRESS EXECUTE TO CONTINUE

PRESS EXECUTE TO CONTINUE

[illegible]

	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	5
ACTIVE [illegible]	20	[illegible]	50
SMALL [illegible]	25	50	25
MARGINAL PROB	34	35	30

Table 4-4

FINAL PROBABILITIES FOR ALL SCENARIOS (Continued)

AD-A091 566 DECISIONS AND DESIGNS INC MCLEAN VA F/G 9/2
THE DECISION TEMPLATE CONCEPT.(U)
SEP 80 C W KELLY, R M GULICK, R R STEWART N00014-79-C-0152
UNCLASSIFIED PR-80-17-99 NL

2 OF 2
AD
A091566

END
DATE
FILMED
12-80
DTIC

```
        |U S POLICY |
         -----↑-----
              |
       ↑--------------------↑
  ____|____          ____|____
 |         |        |         |
```

PRESS EXECUTE TO CONTINUE

PRESS EXECUTE TO CONTINUE

LIKELIHOODS FOR EVENT U S POLICY

	[illegible]	MULTL
	70	30
MARGINAL PROB	[illegible]	30

Table 4-4

FINAL PROBABILITIES FOR ALL SCENARIOS (Continued)

```
        |FPL SUPPORT|
        ------↑------
              |
     ↑--------------------↑
     |                    |
  ------------      ------------
|EXT SUPPORT|     |ROMERAS REF|
```

PRESS EXECUTE TO CONTINUE

PRESS EXECUTE TO CONTINUE

LIKELIHOODS FOR EVENT FPL SUPPORTGIVEN THE FOLLOWING OUTCOME
OF EVENTS EXT SUPPORT AND ROMERAS RE

	WIDE	ISOLT A:	NO
ACTVE|HIGH (24)	20	35	45
SMALL|HIGH (36)	35	40	25
ACTVE|QUEST(8)	65	30	5
SMALL|QUEST(12)	5	15	80
ACTVE|NOT C(8)	20	40	40
SMALL|NOT C(12)	35	40	25
MARGINAL PROB	21	29	50

Table 4-4

FINAL PROBABILITIES FOR ALL SCENARIOS (Continued)

```
                 |EXT SUPPORT|
                  -----↑-----
                       |
          ↑----------------------↑
     _____|_____         _____|_____
    |           |       |           |

    PRESS EXECUTE TO CONTINUE

    PRESS EXECUTE TO CONTINUE
```

LIKELIHOODS FOR EVENT EXT SUPPORT

	ACTVE	SMALL
	40	60
MARGINAL PROB	40	60

Table 4-4

FINAL PROBABILITIES FOR ALL SCENARIOS (Continued)

```
                |ROMERAS REF|
                 -----↑-----
                      |
        ↑-------------------↑
 _______|______      _______|_______
|              |    |               |

PRESS EXECUTE TO CONTINUE
```

```
PRESS EXECUTE TO CONTINUE
```

```
LIKELIHOODS FOR EVENT ROMERAS REF

                          HIGH   QUEST NOT L
                             60      20      20
MARGINAL PROB.               60      20      20
```

Table 4-4

FINAL PROBABILITIES FOR ALL SCENARIOS (Continued)

for this illustration, the final results are shown in Table 4-5.

```
                    CONDITIONED PROBABILITIES

                    PROUS RESTR ANTI
                    45    24    31

               PRESS EXECUTE TO CONTINUE...
```

Table 4-5
FINAL RESULTS

4.2 Other Decision Analysis Studies

This section presents summary descriptions of the analyses of four decision problems that were performed in support of the contract sponsor, DCA.

4.2.1 A site selection problem - Early in the contract cycle, at the request of the contract sponsor, a retrospective decision analysis was performed to familiarize and provide the sponsor firsthand experience with the decision analysis approach to problem solving. The problem chosen for analysis had actually been decided the week prior to the analysis, the decision having been made intuitively by the participant in the decision analysis. The DDI analyst was not told in advance what the decision choice had been.

The problem was to select two of three candidate sites for the immediate delivery of a new computer system. All three sites were scheduled to receive similar computers, but whereas two of the computers were available and could be delivered immediately by the sponsor, the delivery of the third computer would be uncontrollably delayed. The key

uncertainty was the length of the total delay in the site becoming operational. The total delay included delays in delivery, installation, software development, and checkout and testing. The delays in installation, software, and checkout and testing were site dependent, as was the impact of the total delay in the site becoming operational.

The decision analysis involved structuring the problem, eliciting probabilities for the possible lengths of the various delays, and eliciting values of regret for the possible decision outcomes. Once the elicitations were completed, the analysis evaluated the information and indicated the implications for choice. Finally, it identified the site which could best tolerate a delay; that is, the site at which a delayed delivery lead to the least expected regret. The site so identified turned out to be the site decided upon by the sponsor a week earlier.

4.2.2 A test-bed location problem - A decision analysis was performed to assist the sponsor in choosing between candidate locations at which to install a WWMCCS ADP test bed. The analytical approach used in the analysis was that of hierarchical multi-attribute utility (MAU) assessment. The resulting MAU model included some forty evaluation criteria. Eight sponsor participants provided values of the relative utility offered by the candidate locations with respect to each criterion. The participants then specified relative importance weights for the various criteria, proceeding in a systematic manner up through the hierarchy.

The analysis indicated the overall utility associated with each site and identified that site having the greatest utility for the participants.

4.2.3 A research and development investment strategy - At the sponsor's initiative, nine representatives of DCA's

Command and Control Technical Center participated in a five-hour decision analysis to develop rationale to support an optimal investment strategy for new WWMCCS ADP applications. Nineteen alternative areas were identified for potential investment of research and development resources; each area had many levels of potential investment.

The approach to solving the problem was to define the alternative areas and levels for investment, to identify their interdependencies, to specify their individual costs, and to determine their relative benefits. Assuming the validity of the cost and benefit values, the optimal strategy would be to invest in the order of decreasing cost-benefit ratios. The elicitation procedures and computer-based decision aids used in the meeting supported this approach.

4.2.4 <u>An evaluation of requirements for ADP support of crisis action functions</u> - Representatives of DCA planned to install and test selected ADP components of a testbed command and control system at one of the Unified Command headquarters. At issue was the specific crisis action functions that would benefit the most from improvements and advancements in ADP support. If these functions could be identified, the testbed would be designed accordingly, i.e., funds for advanced testbed hardware and software would be allocated to components of the ADP system which, potentially at least, could provide the greatest improvement in the crises management process.

A computer-based evaluation model, based upon earlier DDI work related to technical system evaluations, was designed to identify and rank the potential ADP crises support improvement areas. The structure for the model is described in detail in Appendix A entitled "ADP Support Requirements Evaluation." The methodology involved in the evaluation

process is described below. The results obtained from the evaluation have been delivered to the DCA project office in the form of computer printouts.

Since the testbed was to be installed at CINCPAC, plausible crisis situations likely to occur in the WESTPAC area were identified. These included a range of confrontation and conflict scenarios for each of several areas--Korea, Indo-China, Taiwan, Japan, Philippines, and U.S. Naval Forces at sea. With regard to each crisis scenario for each of the areas, the information on enemy and friendly forces that would be needed by the CINCPAC battle staff was identified. Having identified the information needs of the staff, the next step in the process was to describe the ADP support required to store, retrieve, sort, analyze, and display this information in a timely manner as part of the crisis management process. For example, each information category was specified in terms of the content or detail required, the time-late factor, and how it should be analyzed and displayed.

Finally, weights were assigned to describe the improvements that could be achieved in a functional area by introducing an advanced ADP system, and values were assigned to represent different levels of improvement that could be incorporated into the design given adequate funding. These computer inputs, which were estimated by DCA personnel, were used to compute measures of benefit for various levels of improvement and display the overall value of different combinations of ADP support.

5.0 COMMAND AND CONTROL TECHNICAL CENTER (CCTC) PLANNING CONFERENCE

5.1 Crisis Action System Symposium

A Crisis Action System Symposium was convened in MITRE's conference facilities at McLean, Virginia, on 23-27 July 1979. Attendees included representatives at the 0-5 level from the various unified and specified commands and from the service staffs and the Joint Chief of Staff. DCA representatives were in charge of the proceedings, and they received technical and administrative support from MITRE and DDI.

The conferees addressed the problem of ADP support of course-of-action development, execution planning, and execution initiation/monitoring. Major emphasis was given to the course-of-action development phase of crisis management. DDI, in preparation for the conference, developed a crisis action scenario which was to serve as a framework for the conferees' discussions. In addition, a set of questions was prepared to focus the discussions specifically on the course-of-action development problem and disseminated to the conferees. The scenario and set of questions appear in Appendix B.

Representatives of the unified and specified commands tended to stress recent operational problems encountered within their commands and found it difficult to identify or reach a concensus in identifying areas where advanced ADP technology could significantly improve the overall situation. They were frustrated by the fact that they had been unable to make the current ADP system perform to their satisfaction. Typical comments were: "I have a file on 6000 units but it's full of errors"; "Our files are filled with coded data that only the J-4 or J-6 can interpret"; "Our

command is operating with different software than the NMCC"; and "Everyone gets a big glob of data instead of the information they need."

One of the major problems that most of the conferees could agree upon concerned the following: the implementing commands were generally late in "getting the word," and because their commands were not able to participate in the early planning phases of the crisis action process, the options generated by the NCA and JCS were exceedingly difficult to implement. The conferees agreed that subordinate, implementing commanders need to know as early as possible what is needed where, by what time, and for what purpose. This problem caused DCA and DDI to reemphasize ADP support of the option-generation process and to initiate operational experiments in deployment management.

5.2 Concept for Deployment Management Operational Experiments

The apparent inability of ADP to support adequately decision makers in a dynamic command and control crisis environment was recognized by the Deputy Secretary of Defense in a Memorandum dated 24 June 1976. This memorandum called for a program to identify and demonstrate specific ADP applications which offer significant potential for improvement of crises action management. Although three years later there appears to be good agreement on the specific problem areas requiring attention, a concensus regarding positive corrective actions in the form of new ADP systems and data bases has not yet emerged.

One specific problem area, that of generating and selecting action options, is exacerbated by the pressures from the highest authorities to provide "instant courses of action" as soon as they learn that a potential crisis situation

is developing. As a rule, the NMCC is given exceedingly close deadlines, measurable in hours and minutes, for developing and presenting a preferred course of action to the President and his staff for approval. This is in spite of the fact that the option-generation function is a highly creative process that requires large amounts of accurate data. Under the present system, it takes time to collect, validate, and digest these data. It is this combination of factors--the need to access accurate information, to create new options and to meet deadlines--that has caused the option-generation process to suffer and underscores the need for improved ADP support.

The option-generation process is critical to the entire crisis action system. For all practical purposes, it establishes the ceilings on forces, resources, and time for the military action that follows. If it is done slowly or inaccurately, the impact is felt by all the subordinate commands and agencies throughout the system. On the other hand, if early on a set of military objectives are clearly defined, a command arrangement announced, and a course of action coordinated with the supported commander, the follow-on implementing actions required of the subordinate commands can be implemented in an orderly and timely manner.

Historically, the application of ADP to crisis support has focused on operational reporting and status keeping. It has been notably unresponsive to senior staff personnel charged with developing and recommending courses of action to the National Command Authority. Although there are many reasons for this and most of them have been well documented, one is worth noting. Early in the crisis, there is not only the tremendous pressures from highest authority for an immediate course of action but also a requirement to "close-hold" the information concerning the situation and what might be done about it. This security constraint not only

tends to centralize course-of-action development within the JCS but often limits the process to a small number of senior personnel who have learned to work such problems with little or no ADP support.

One consequence of this is that the crisis action system can become "locked-in" on a course of action that is exceedingly difficult for the supported commander to implement. Due to the close-hold requirement, available JCS and subordinate commands data files are largely ignored. In many instances, the information used in the plan is obtained and disseminated informally by secure telephone from one "flag" officer to another. When the plan or course of action is approved by higher political authorities, the troop, aircraft, and munitions data that had been obtained informally and outside of the system become ceilings and constraints within which the supported command must operate.

The situation during crisis action development as perceived by representatives of the subordinate commands can be characterized as follows: They are left out of the situation during the early option-generation and planning stages because of the need for "instant options" and the "close-hold" caveats. This is precisely the time when they believe they could make a significant contribution with their access to accurate and detailed information and working knowledge of the status of their forces. When they are subsequently given full access, the plan may contain inaccurate information and unrealistic constraints which they have neither the time nor authority to correct. Discussions during the CAS workshop concerning how ADP support could improve this situation tended to focus on what forces (by unit designation) to use, where are they located, what their status is, and what aircraft should be used to transport them. The argument went that such data files, if accurate and accessible by all WWMCCS participants, would lead to faster and better coordinated courses of action planning.

Over the years, the argument concerning how much contingency planning can be done in advance has gone almost full circle. During the Eisenhower presidency, the approach was to develop a range of contingency plans which could be kept up to date and accessed when needed by the simple push of a button. Later on, it was concluded that the political and military situation changed constantly and therefore such a system would not work. Today, it is generally agreed that unless commands have developed a sound set of basic plans in advance (this is in lieu of a specific contingency plan for every situation in every country), they will be off to a very slow start when a crisis arises. Therefore, one requirement is to have a complete set of rapidly accessible, ADP-based plans with unit status and designation, skeleton organizations, Task Force numbers, communications information, and deployment data that can be used as a basic framework on which to build. As a retired service chief put it recently, "The design objective of this particular element of the ADP support should be to keep the senior officers and civilians off the telephones."

Developers of ADP support for the option-generation process should recognize that the option-generation activity will be taking place almost simultaneously at the Washington level and the subordinate CINCs level. It must go on at the JCS level because of the constant demand from higher authority for detailed information. It should, of course, proceed at the unified and specified command level because of their regional knowledge and closer contact with their forces. Regardless of how desirable it might be, option generation cannot be thought of solely as a step-by-step procedure that proceeds serially from A through B and C to Z. At best, it is a highly iterative process that involves the subordinate CINCs, the JCS and the Secretary of Defense, and the President and his staff. Therefore, the requirement for ADP support is to ensure that a common perception of the problem

and potential solutions are developed among the WWMCCS participants. Decision aids of the kind described in this report should help all concerned visualize the same set of options, range of uncertainty, possible outcomes, and evaluating criteria.

5.2.1 Recommendations - Future ADP support and applicable experiments related to the course-of-action development phase of crisis management should be focused on two principal objectives: to speed up the option-generation process so that a large number of potentially suitable options can be screened and evaluated in a short period of time, and to add visibility to the option-generation process so that the appropriate WWMCCS participants can contribute during the early phases of crisis management. Specific recommendations for ADP support/experiments designed to achieve these objectives are as follows:

- Together with a complete set of ADP-based basic contingency plans, provide a series of readily accessible pre-canned sets of options for each basic contingency plan. When a crisis occurs, the appropriate set of options can be displayed, screened, and evaluated by the operator through the computer console; the less suitable ones can be eliminated by a process that involves answering specific questions which describe the current crisis situation. The questions posed by the option-screening program involve such key points as how soon action must be taken, the nature of the operating environment (how hostile), distances from currently available and deployed forces to the crisis area, and the estimated capabilities of enemy forces.

- After all of the less attractive options have been eliminated, the computer program will provide additional routines for modifying and improving the remaining options. This involves a series of pre-programmed questions designed to identify weaknesses within the remaining options and provide pre-programmed recommendations for improving the options. Through this program, the operator will be able to access a set of data files containing information concerning the availability and readiness of additional combat and support units, helicopters, munitions, supplies, airlift, and so on. These are the building blocks the operator would have immediately available for modifying the options.

- Provide a video teleconferencing capability between the JCS and supported CINC, which also embeds the decision-analytic framework outlined above so that all WWMCCS participants can contribute simultaneously to the option-generation process within the same logical framework.

6.0 THE CRISIS ACTION SYSTEM--SOME BEHAVIORAL ISSUES

6.1 Introduction

Several participants in the Crisis Action System (CAS) Symposium offered critical comments on the system. In their view, the CAS, as described in JOPS, Volume IV, constituted a commendably logical set of procedures but placed undue emphasis on administrative tasks. CAS also failed to highlight explicitly many elements of the decision-making process that are at least as important determiners of crisis performance and the design of WWMCCS as are those administrative procedures. That is, the elements of reducing information to choice are not addressed by the system.

This section summarizes some preliminary thoughts on those elements of the decision process which deserve more recognition and study and which seem to have substantial implications for WWMCCS design. Included are tentative findings on these design implications and an outline of the general approach for developing a more thorough set of WWMCCS design requirements.

Figure 6-1 depicts the flow of the CAS. The focus in this section is on the following elements of the CAS, which are the essence of the decision process embedded in it:

Phase 1: Problem Recognition and the Commander's Assessment;

Phase 2: JCS/NCA Assessment and Option Development;

Phase 3: Courses of Action Developed by CINC Estimate and the Recommended Course of Action; and

Phase 4: The Decision.

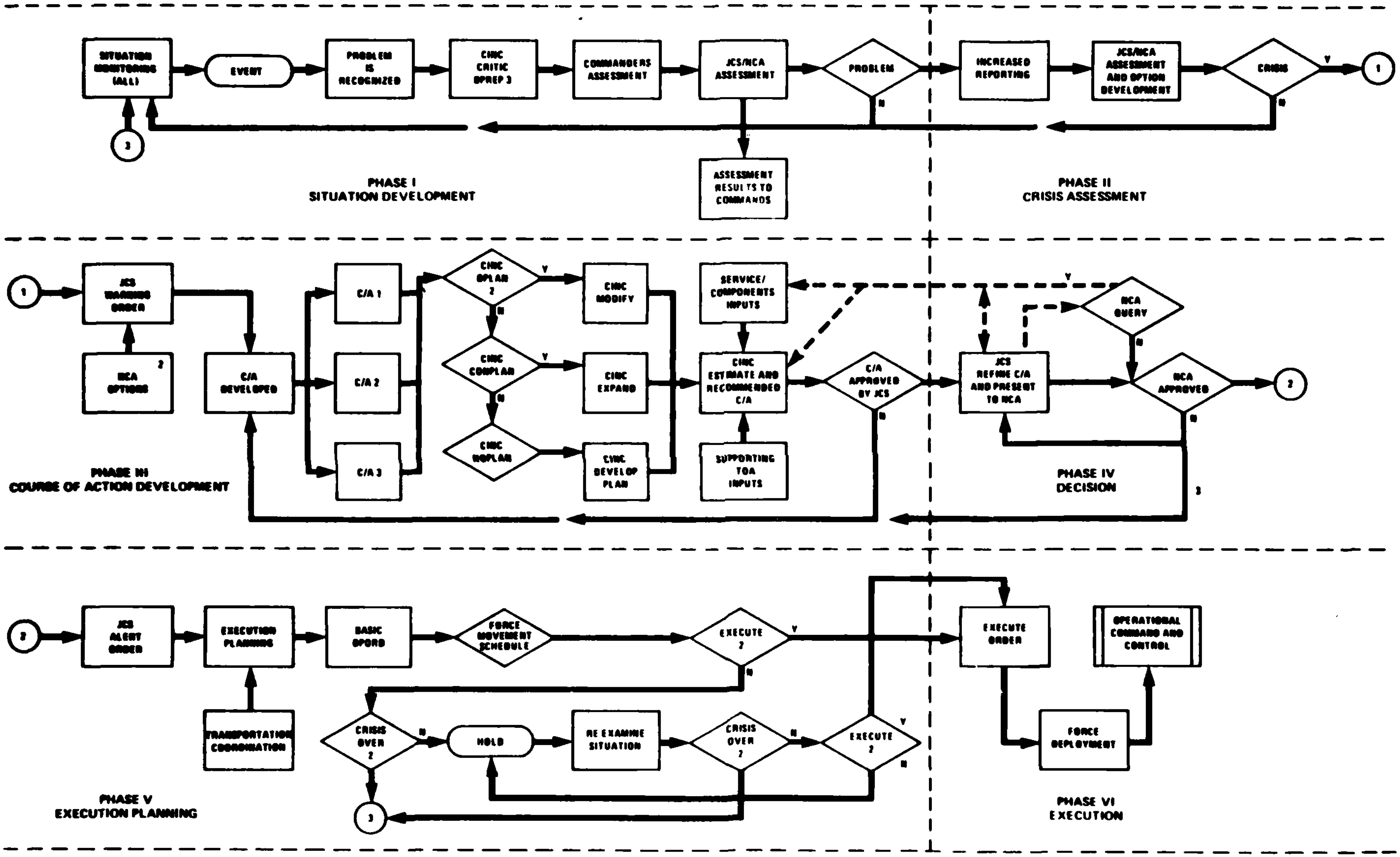

Figure 6-1

CRISIS ACTION SYSTEM (CAS)

6.2 A Decision Process Model

Given the above description of the CAS decision process, a three-step approach can be employed to translate it into general implications for the WWMCCS architecture. The first step is to define an abstract, CAS-specific decision process model. The model is based on interpreting the CAS elements in light of specific event scenarios and describing what actions must occur to carry out the decision process. The second step is to specify, drawing upon the psychological literature, the human information processing capabilities necessary to accomplish each step identified in the process model. The third step is to create approaches for aiding human information processing performance in those areas where important cognitive limitations and biases have been noted.

To facilitate the development of a CAS-specific process model, the analysis of each scenario should be guided by a very general decision process model, such as that taken from from Schrenk (1969).[1] This model, shown in Figure 6-2, is not intended to represent either actual decision-making behavior or to fit exactly any real decision situation. Rather, it is intended only as a framework to guide the inquiry used to develop the process descriptions. This model, which is similar to others appearing in the literature (see for example Elion, 1969), recognizes eleven steps in the decision process. These are:

1. Alerting: The first phase of decision making is concerned with determining that a problem requiring a decision exists.

[1] Reference citations are listed in Appendix C.

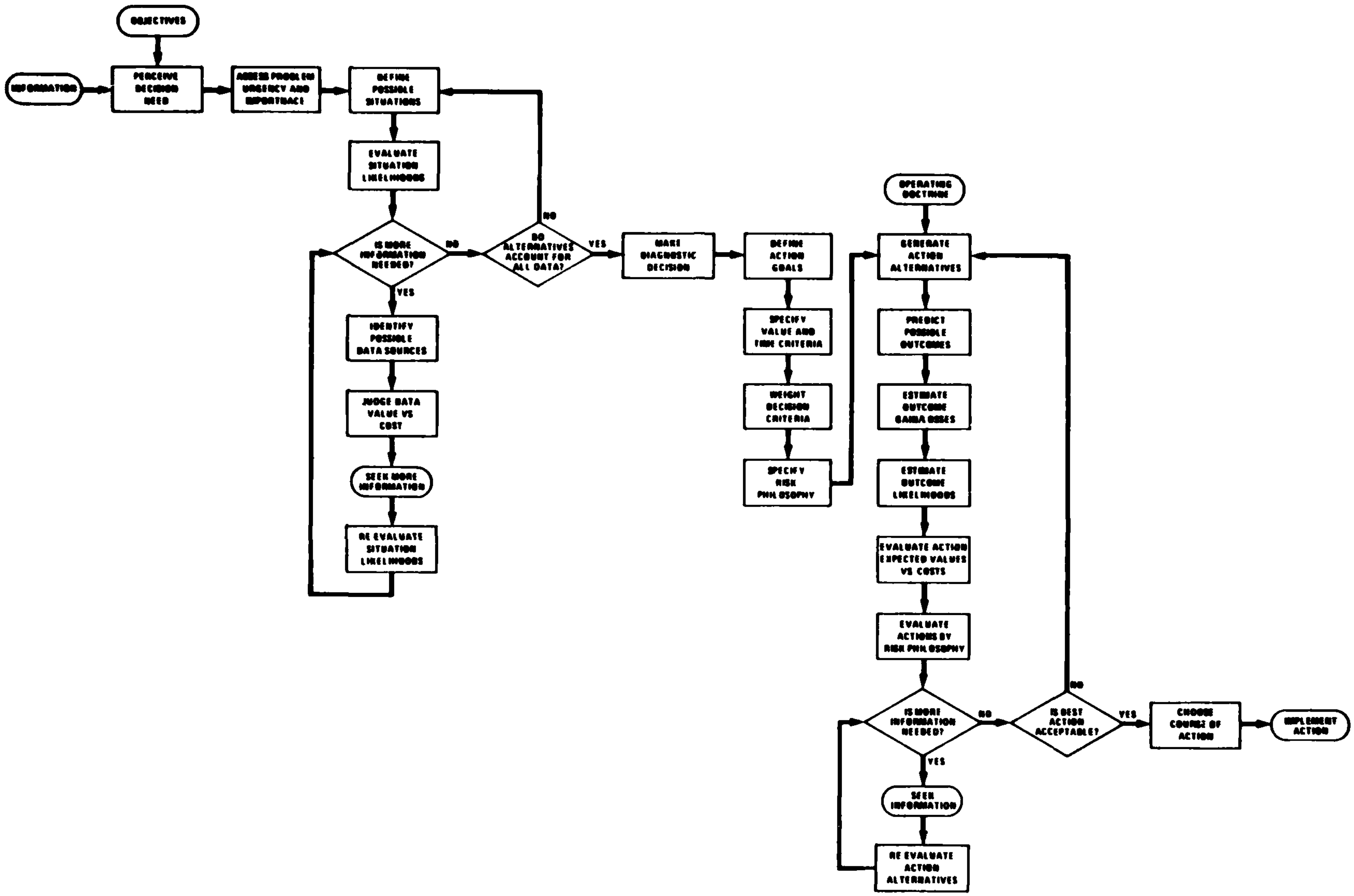

Figure 6-2

A DETAILED DECISION PROCESS MODEL

2. Verification: Is the problem real or a false alarm?

3. Problem definition: What are the elements which define the problem with respect to generating possible solutions?

4. Generation of action options: What approaches for solving the problem are available?

5. Generation of decision outcomes: What will the consequences be of executing one of the action options?

6. Assignment of preferences to outcomes: What is the relative value of each possible outcome of the decision?

7. Assessment of the likelihood of outcomes: Given that a particular action option is executed, what is the likelihood that any of the particular outcomes identified in step 5 above will actually occur?

8. Option selection: Given the preferences for outcomes, assuming that they occur with certainty in the assessment of the likelihood that any particular outcome will occur, what is the risk associated with each action option?

9. Execution of the selected option.

10. Monitor the execution.

11. Evaluate the results.

An examination of Figures 6-1 and 6-2 indicates that approximately the first half of Figure 6-2 (the first four steps above) concerns the problem recognition, assessment, and option development elements of the CAS; the remainder (next four steps) concerns course of action recommendations or decision elements of the CAS. Thus, Figure 6-2 expands the particular CAS elements (presented in Figure 6-1) which can be used to study the crisis decision process in more detail.

6.2.1 Alerting - The alerting (warning) phase involves both the recognition or inference that a problem exists and a decision to communicate this inference to senior decision makers. In most situations--particularly in non-nuclear crises--alerting will be a group effort with considerable teleconferencing among command post watch officers at the national level when an unexpected event occurs. The watch officers exchange information and report those findings and conclusions they believe should be handled at the NCA level. One factor which exerts a profound but often unremarked effect on alerting is the degree of familiarity of watch officers with the definitions of "problems." This involves knowledge of national objectives and an ability to discern changes in certain situations that will lead to conflict with these objectives. That is, they cannot report every change from some sort of perceived status quo situation or norm. There must be clearly defined guidelines which state that, "This particular situation is one which if it occurs would be of interest to the NCA. That situation is not of interest."

A key part of the alerting process is the formulation of hypotheses which describe those situations of interest, provide plausible explanations for sets of observables, and serve as a focus for information gathering or filtering and inference making. There is some evidence

which suggests that people have difficulty independently producing complete hypothesis sets but are, at the same time, unlikely to realize their omissions. Research suggests that "what is out of sight is effectively out of mind"; thus, in the short run inadequate hypothesis sets could substantially limit problem-alerting performance.

The objective of the inference-making phase of problem alerting is to weigh evidence and assess the relative likelihood of each hypothesis. Substantial experimental evidence suggests that this is a task in which human performance is badly suboptimal. Often cited problems include: over-interpreting evidence, conservative use of evidence in the updating of forecasts, confusing assumptions with fact, overestimating low likelihood of events and underestimating high likelihood of events, failing to sufficiently degrade the diagnostic impact of unreliable evidence, and downgrading the significance of older but still valid data. These and other information processing problems have been well documented in experimental settings; however, at issue (Phillips, 1980) is the extent to which these findings can be generalized to real-world intelligence analysis and other areas where inference is done routinely by professionals. While these professionals perform, in general, no better than any other subjects in an experimental setting, a number of researchers are questioning whether these experimental paradigms represent realistic tasks.

In any case, at least two other problems may be of greater practical significance in alerting. One is the fact that degrees of likelihood are most often described using very ambiguous verbal qualifiers (Kelly and Peterson, 1972). For example, an analyst who believes an event has a high likelihood of occurrence may use a verbal qualifier, such as "probable" to communicate this opinion. Someone else may interpret this as implying a much lower probablility

than the analyst had in mind. The ambiguity of verbal qualifiers is well documented and extraordinarily pervasive, but the seriousness of the miscommunication which can be engendered through the use of verbal qualifiers is not well appreciated.

More serious is the fact that to "alert" someone, analysts must make a conscious decision to tell someone of higher authority what they believe; an analyst who "senses" ever-increasing likelihood that something is badly out of line but fails to report this fact to anyone does not provide alerting. Recent evidence (Stewart, Kelly et al., 1979) shows that this is exactly what may happen in a number of situations. In simplest terms, the value systems established by many organizations are perceived by analysts as placing a premium cost on a false alarm. Thus, an analyst, to reduce the expectation of a penalty, may wait overly long to report a probable event; alerting may come much later than it should, and, as a consequence, opportunities for action may be lost.

6.2.2 Verification - Concurrently with alerting, checks are initiated to validate initial reports and to develop independent confirmation of the occurrence of the reported events. Details concerning these verification procedures can vary considerably depending upon the situation, that is, how time urgent and how critical it might be.

Basically, two approaches can be taken to verify the occurrence of an event. One approach--the most frequently used--is to ask another (hopefully independent) source about the occurrence of the event in question. The second approach is to collect information which pertains directly to the reliability of the source reporting the event in question, but which may not have anything to say directly about the occurrence of this specific event. There

are of course many situations where varying combinations of these approaches can be used.

Perhaps the most appealing approach is to try to collect information from an independent source about the event in question. However, it may be the case, although seemingly counterintuitive, that collection of information about source reliability will have a far greater diagnostic impact than information which is inferentially collaborative of the event in question.

The problem of determining which approach is preferable is complicated and requires consideration of several independent assumptions about source behavior. The mathematical development of this issue (Shum and Kelly, 1973) suggests that most of the relationships between inferential impact of evidence and source reliability are counterintuitive. This is to a degree verified by experimental findings which suggest that people frequently (1) overvalue the diagnostic impact of a report from an unreliable source and (2) undervalue the impact of information that pertains to source reliability but that does not directly refer to the event in question.

6.2.3 Problem definition - This phase begins the process of generating detailed alternative courses of action. Broad categories of options--for example, military or political--are accepted or rejected based upon (1) the extent to which their perceived consequences support the decision maker's objectives and (2) considerations of the feasibility of implementing each option.

One of the controlling factors in problem definition is the extent to which participants hold a common perception of the decision maker's objectives. In the Cuban missile crisis, the Mayaquez crisis, and the Korean "tree

chopping" incident, a surprising amount of discussion was devoted to objectives. In each case the participants found that there was considerable disagreement and conflict about what the objectives were and consequently what broad course of action was preferred. In many crisis situations, this initial screening of decision options, unlike what occurred during the preceding situations, probably will not be the subject of much intellectual deliberation. Rather the initial screening may be achieved on the basis of a very hasty surmise, sometimes limited to crude perceptions of what is happening. This occurs partly because in most crisis situations decision makers are likely to display a narrowing of time perspective along with other symptoms of cognitive stress. As a consequence, they may unduly restrict the kinds of action options they wish to consider further, perhaps feeling under pressure to "get on with something" lest events slip out of their control.

6.2.4 <u>Generation of action options</u> - The development of courses of action drives the entire crisis action process. If the "best course of action is not generated, it is unlikely that it will eventually be selected. Yet this problem of omission is given scant notice in the crisis procedural literature, for example, JOPS IV, and indeed is not mentioned in much of the literature on decision making.

With respect to the crisis action system, three factors tend to control the generation of courses of action. First, as described above, determining the extent to which whole categories of options have been initially screened is infeasible. Related to this is the need for a clear statement of objectives. The CINCPAC J-3, discussing the need for a statement of objectives, said, "The point we wish to make is that the way the problem is defined shapes the options available." A clear statement of objectives was missing early on in the Mayaguez crisis and resulted in

considerable confusion about the appropriateness of certain kinds of actions.

The second factor constraining course of action development is that most thinking about courses of action is oriented toward conventional war. That is, there is a tendency to focus more on logistics and deployment planning than operational courses of action. The general feeling is that, "If we can handle a war, we can handle crises." The differences between conventional war and crises (in terms of the speed of onset of the situation, its short duration, required speed of response, limited size of the threat and possible conflict) and the fact that the character of operational options may be quite different than in war are ignored for the most part. This emphasis on logistics and deployment planning leads to a great deal of discussion about <u>what</u> forces to use, <u>what</u> aircraft and so forth, but little discussion about operational concerns: <u>when</u> to use them, and <u>where</u> to strike. Determining force availability and lift capability is not a substitute for option generation.

All of this detailed planning (1) leaves little time for the creative thinking needed to generate alternatives, (2) de-emphasizes the basic issue of whether or not the selected force can do the job, and (3) emphasizes evaluating the impact of removal of forces on other assigned missions. That is, the focus tends to be on how a given course of action impacts other assigned missions versus how it would impact desired crisis outcomes. For example, CINCUN should be informed not of the impact of the removal of certain forces on his prime mission of the land defense of Korea, but rather the options should be screened in terms of how well CINCUN's forces can accomplish the desired crisis objectives.

The third and perhaps most telling factor controlling course of action generation is the presence of extraordinary pressure to generate options quickly. In times of stress, as mentioned earlier, creativity can be expected to suffer; therefore, option generation, inherently a highly creative process, will be degraded. Yet there appears to be extraordinary pressure (1) to generate courses of action very early on and (2) to ensure that they are complete and adequate, as they will have a decisive impact on allowed operational ceilings. For example, one JCS action officer said, "Whatever you come in with had better be accurate, plus or minus 5%, because it will set a ceiling you will probably have to live with," and then later, "Early phase, quick response is key."

There are two important issues here. First, early in crisis onset, information about objectives and constraints which might apply to the problem is very closely held. As a result, the JCS tends to dominate course of action development. Second, the necessity for quick response ignores the fact that objectives and options will change as a crisis evolves; thinking may thus become polarized and, accordingly, creativity may suffer.

6.2.5 Generation of decision outcomes - When courses of action have been generated, all of the consequences associated with each option must be communicated to key decision makers. As mentioned above, too often it is assumed that one consequence of each course of action is that the military objective will be attained and the only other consequence usually given any consideration is the impact of force deployments on the ability to execute primary mission responsibilities.

Clearly, many other consequences could result, but if the focus of the decision maker is limited strictly

to the problem at hand, they may not be considered. For example, a naval blockade of Iran might be evaluated only with respect to its impact on the release of the hostages. Other relevant consequences might involve a confrontation with the Soviets, a negative effect on our allies, the stability of the political structure of Iran (i.e., might it disintegrate and pave the way for a Soviet takeover?), and the political opportunity for an invasion of Iran by Iraq.

Two issues are important: first, the crisis action system must help expand the horizons of the decision maker, help generate consequences for each policy objective (they will often conflict), and revise these consequences in response to changing environments. This last function is particularly important because of the tendencies of decision makers under stress not to want to take the time to re-evaluate the situation. Second, in virtually all crisis situations the decision process will initially center on whether to "act now" or to "wait for additional information." To decide what should be done, the decision maker must also consider the consequences of "waiting" versus "acting now."

6.2.6 Assignment of preferences to outcomes - There are, or at least there should be, two determiners of choice: the values assigned to the various possible consequences of a decision and the likelihood that each of those consequences will occur. In most real-world decision-making processes, no attempt is made to think formally about the relative attractiveness of all the possible consequences of a decision, nor is the formal thinking process highlighted in the military literature on how to make decisions. There are two problems with assigning preferences to the consequences of decision outcomes.

The first problem is that it is by no means obvious that the value structure used by decision makers will

be well defined. Decision makers like to think that they have reasonably well-defined opinions regarding the desirability of various future events, opinions that may have been developed in response to simple and repetitive previous problems. Their value structure becomes suspect, however, when the issues are unfamiliar and complex. In those situations the decision makers may have never considered the implications of the values acquired in simpler settings. As a result, they have no clearly articulated preferences; and, in a fundamental sense, their values may be logically incoherent, not thought through. In trying to determine acceptable levels of risk, for example, decision makers may be unfamiliar with the terms used to formulate the issues; they may have contradictory values; and they may occupy different roles in life which may produce clear cut, but inconsistent values.

The second problem is that even in those situations when decision makers have clearly defined preferences regarding the various attributes of the decision consequences, they may not know how to aggregate these individual preferences across all attributes. That is, one consequence may be attractive with respect to one objective but unattractive with respect to another objective. In such situations, people have difficulty combining individual preferences for each attribute into a single aggregate preference reflecting the overall preference of a particular consequence across all attributes. In addition, decision makers often exhibit a tendency to pay more attention to the positive attributes of each consequence than the negative attributes.

A crisis action system must explicitly require that each decision outcome or consequence be described with respect to its military, political, economic, and social aspects. Then, each relevant aspect of each outcome must be evaluated according to an appropriate measurement model by

some person or some group. Which measurement system is used and by whom are extremely important considerations. If different persons or groups are conducting the evaluations, the questions of interperson or intergroup reliability must be resolved. The use of some formal measurement procedure will tend to compensate for a decision maker's inability to evaluate intuitively multi-attributed consequences.

6.2.7 Assessment of the likelihood of uncertain event outcomes - The likelihood that any given consequence will occur is conditional upon a decision option having been selected. This fact has been neglected in the development of most decision-making processes such as the crisis action system. There are three significant issues here. The first is that any decision-making system should recognize the need for explicit likelihood judgments for the relevant consequences of a decision. If the likelihood of the various decision consequences is not formally considered in the decision-making process, the resultant choice may be dictated more by what the decision maker would prefer to have happen rather than what a specific likelihood judgment might show is most likely to happen. Second, these likelihood judgments should be explicitly conditioned by the courses of action under consideration. They should reflect the capacity of these options to influence future events. Thus, these likelihood judgments should be based on or conditioned by each of the courses of action in turn rather than reflecting some sort of nominal status-quo-like state of affairs. This will require that the intelligence community work much more closely with the operations and plans communities than has previously been the case; the failure to do so may mislead the decision maker about the probable consequences of the decision. Finally, and this has been mentioned earlier, these likelihood judgments should be communicated in the form of numerical probabilities rather than through the use of ambiguous verbal qualifiers.

6.2.8 Option selection - The final step in constructing the decision process model is that of integrating opinions about the likelihood of a consequence and its attractiveness into the selection of a course of action, that is, weighing risks against benefits. Research conducted over the past two decades has shown that man has severe cognitive limitations that force decision makers to construct simplified models for dealing with complex decision problems. The effects of these simplified models, which are manifestations of a bounded rationality, can lead people to make decisions which are satisfactory but by no means optimal. This process is called "satisficing." The extent to which the differences between the satisfactory decision and an optimal decision are significant is difficult to estimate in general. In certain situations, the differences may be so slight that the additional effort to develop an optimal strategy would not be worthwhile. In other situations, however, these differences may be profound, and failure to strive for optimality could be crucial.

Examples of satisficing are plentiful. For example, during an exercise at Headquarters U.S. European Command in 1977, a senior decision maker was faced with selecting an advance air base to support NATO forces in a central European conflict. He apparently had several criteria in mind and proceeded to evaluate quickly a number of available air field locations against these criteria, rejecting each in turn until he found one which satisfied minimum thresholds on all of the criteria. A decision analyst shadowed this process, using a computerized decision aid, and developed a better option than the one selected by satisficing. The analyst was able to convince the decision maker that the option recommended by the decision aid was substantially preferable to that which he was prepared to recommend based on purely intuitive analysis. Under conditions of stress, it

is likely that the satisficing approach will further deteriorate in quality because the decision maker will consider even fewer criteria and will be less exact in setting his thresholds.

6.3 Some Behavioral Observations

Examination of the crisis action system in the light of the decision process model suggests some elementary facts about human decision makers that are important for system design.

First, it is important to emphasize the distinction between a decision system and a human decision process. A decision system, consisting of a combination of men, machines, and standard procedures, will have characteristics that are mainly controlled by the design of the system. Human limitations will limit the performance of a decision system primarily to the degree that they have not been foreseen and taken into account in system design. One goal, therefore, of decision system designers should be to design the system around their knowledge of human limitations so that the task of the system will be performed well.

The "system" described in JOPS IV involves a large number of well-integrated human participants (e.g., the various CINCs). But the extent to which the National Command Authority (NCA) participates in the system will be a function of the NCA's past experience and training with the sytem, confidence in it, personal decision-making characteristics, and so on. In the present time frame, these human issues dominate the overall system performance.

For example, consider, as a hypothetical worst-case, a situation in which the NCA has little or no experience with the system, has never exercised it or participated in

training exercises, knows generally the information subsystems on which it depends but is not intimately acquainted with their technological properties, their potentialities for error, or their operators and operational procedures. Obviously, the actions taken by the NCA will depend primarily on personal characteristics but, nevertheless, some hypothetical observations can be made about what might happen by applying results obtained from research on human decision making in both laboratory and real-world situations. The following observations have implications for the WWMCCS architecture and provide a means of generalizing beyond the specifics of a particular scenario.

6.3.1 A hypothetical observation of a crisis - The crucial factors in a crisis situation from a president's point of view are (1) a strong (even violent) presupposition that the catastrophe of which he is being warned has never happened before and is therefore extremely unlikely to happen today; (2) a profound concern with the disastrous consequences of an incorrect positive response; and (3) extreme sensitivity to, and resentment of, the time pressures inherent in the situation. All three of these factors are certain to lead to delays in acting. For example, in the case of a nuclear attack with no strategic warning, those delays are virtually certain to be so great that no weapons launches will occur until after the confirmed occurrence of nuclear detonations within CONUS, given the present crisis action system design.

Consider first the extreme unlikelihood (in the technical language of decision theory, the very low prior probability) of attack. A direct consequence of the logic of decision theory, verified in many experimental and practical contexts, is that the farther the prior probability is from the point at which some action is appropriate, the more confirming evidence it will take to produce that action.

Additional problems arise if the president doubts the validity or the implications of that evidence presented to him. If evidence suggesting a preposterous or highly unpleasant conclusion is presented, the first tendency will be to discount the evidence. Recognition of this aspect of human behavior is built into the present system in the form of methods for checking the accuracy of reports reaching NMCC for verifying that such reports do not represent either system error, operator error, or exaggeration. But recall we are assuming the president is ill-acquainted with the existing system--and therefore ill-acquainted with its methods of verifying information and correcting errors. He will probably want to check the evidence for himself. If the evidence is highly technical, depending on complex electronic sensing or even more complex electronic checking systems, he probably will be unable to assimilate the logic of the technical arguments and procedures in the available time. His alternatives are either to believe the evidence because he has faith in those who relayed it to him, or to disbelieve the evidence only because it is so obviously preposterous. Extensive experimental and anecdotal evidence suggests that he will undoubtedly do the latter. (See for example, Myers, 1972).

The matter is made more complicated by the fact that the president is unlikely to directly challenge those people who informed him of the evidence. Instead, he is much more likely to seek other sources of information. Some of this information collection will be a genuine attempt to explore alternative hypotheses; some will be simply an attempt to obtain more information in order to overcome the very low prior probability of the evidence. But some (and this is crucial) will be an attempt to delay the need for an apocalyptic decision by seeking more and more information in hopes of achieving greater and greater certainty of the correctness of the evidence.

The latter kind of delay is a sophisticated version of the well-known phenomenon of "freezing" in the presence of an unanticipated danger. No one as experienced as the president is likely to "freeze" literally (even though he too will be affected by thoughts of his own and his family's safety). But a kind of intellectual "freezing" that substitutes ever-expanding demands for more and more information for acceptance of a risky decision is psychologically much the same thing.

Another factor likely to increase the demand for additional information--and, consequently, lengthen the delay--is the well-known phenomenon of human conservatism in information processing. (For reviews, see Edwards, 1968; Slovic and Lichtenstein, 1971). In a wide variety of contexts, decision makers are clearly unable to assimilate the full diagnostic impact of data, regardless of the level of prior probability. The greater the diagnostic impact should be, the more conservative they are. The implication is that even if the president is willing to accept the information he receives as valid and believable, he may simply insist on waiting for more of it to come in, even if that means waiting until the time at which meaningful action becomes impossible. This is especially likely if such delays bring into play new evidence, including, ultimately, nuclear detonations.

Finally, the complexity of the decision space (set of options) facing the president serves both to slow up and to complicate the decision. Clearly it should, and will, take more time and more information to pick the best from ten options than from two. Experimental evidence indicates this is so; in fact, in laboratory studies, a linear relationship has been found between decision time and the logarithm of the number of equally likely options or degree of uncertainty (Garner, 1962, p. 45-46). The availability of hedging (or waiting) options makes the problem due to option

multiplicity even worse. When payoffs are apocalyptic either way, the tendency to hedge will be enhanced. Research literature shows that almost everyone is "risk averse" when the stakes are very high, which simply means that people prefer options with less extreme consequences to those with more extreme consequences, even when the latter are clearly preferable in a well-defined and context-appropriate sense (see, for example, Coombs and Huany, 1968).

Suitable combinations of training and system design can be used to overcome most of these kinds of problems--but not ex post facto. Both must be taken fully into account when the crisis action system is originally designed.

A key problem in the design of WWMCCS from a behavioral standpoint is the problem of interfacing the president and NCA with the rest of the system. If we could identify exactly who would comprise the NCA, we then could tailor the system to meet their own individual needs. However, since we do not know, WWMCCS should be compatible with the style of almost any decision maker who might occupy that role.

The decision strategy that the president adopts may be a function of whether he is a perceptive or receptive information gatherer and whether he is a systematic or intuitive information evaluator. Perceptive individuals tend to look for cues in a data set, focus on relationships, and jump from one section of a data set to another while building a set of explanatory precepts. Receptive thinkers tend to suspend judgment and avoid preconceptions, be attentive to detail, exact attributes of data and insist on a complete examination of a data set before deriving a conclusion. Systematic thinkers tend to look for a method and make a plan for solving a problem, be very conscious of approval, define the quality of a solution largely in terms of the

method, define the specific constraints of the problem early in the process, discard alternatives quickly, move through a process of increasing refinement of analyses, conduct an ordered search for additional information, and complete any discrete step in analysis that they begin. Intuitive thinkers tend to keep the overall problem continuously in mind, redefine the problem frequently as they proceed, rely on unverbalized cues, even hunches, defend a solution in terms of fit, consider a number of alternatives and options simultaneously, jump from one step in analysis or search to another and back again, and explore and abandon alternatives very quickly.

WWMCCS must accommodate a president that may either be intuitive or systematic. If the president is intuitive, he may not want to understand the analytic processes involved; he may just want to know that he can trust the system. If he is systematic, however, he may be willing to spend the time necessary to understand the underlying structure of the decision system.

WWMCCS will probably be designed by systematic thinkers. The president, a politician, might think either systematically or intuitively. However, for WWMCCS to be most useful, it should incorporate certain features in the system design for intuitive thinkers:

1. The user should have the ability to create an arbitrary order of processing; the system should not impose "logical" or step-by-step sequences on him.

2. The user should be able to define, explore, and play out "scenarios" that may either generate cues or test solutions.

3. The user should be able to shift among levels of detail and generality.

4. The user should have some control over the forms of output and should be able to choose visual, verbal, and numeric displays at varying levels of detail.

5. The user should be able to extend programming, providing input in an irregular and unspecified form.

6.3.2 Other observations - MacCrimmon and Taylor distinguish several attributes of decision makers that are likely to affect the decision strategies that they use. These attributes include perceptual ability and information processing ability. Perceptual ability will influence the president's degree of uncertainty, complexity, and conflict and hence the strategies he considers using on WWMCCS. If a decision template is preprogrammed with all the necessary considerations already built in, then the system does not have to rely on the president's ability to uncover all the necessary considerations. Otherwise, the system is vulnerable to this individual difference in perceptual ability. With respect to information processing ability, individuals can be classified as "abstract" or "concrete" decision makers and as dogmatic or not. Abstract decision makers are efficient utilizers of information and are better prepared to cope with uncertainties and disjointedness in the decision environment. A dogmatic decision maker reaches rapid decisions based on relatively little information; yet, once made, those decisions are confidently and inflexibly held.

Decision makers use specific mechanisms to reduce the strain of integrating information. One mechanism that people adopt is to use only the information explicitly

displayed to them in making their decision. Another mechanism is to begin with a specific structure and adjust from there, but the adjustments are either insufficient or imprecise. Decision makers also exhibit certain biases that affect how well they make the necessary intuitive judgments involved in integrating information.

Biases that reduce decision makers' abilities include the following: not using their prior opinions at all in evaluating information; not adjusting their prior opinion sufficiently based on incoming information; not using all the relevant features of the information in forming opinions, but concentrating only on certain specific dimensions of the information; and, finally, making likelihood judgments on the basis of the mental effort involved rather than on the relevant aspects of information itself.

For WWMCCS, the implications of these biases involve how the decision task should be subdivided, what specific judgments are used as inputs, what information is presented to the different persons who must make the different evaluations, and other requirements such as the displays and training procedures used to support the system.

Human performance research offers insights about the kind of behavior that might be expected when the decision maker is faced with a work overload. Dewar, Goldstein and Weintraut identified, from a survey of the literature, sixteen possible strategies or mechanisms for adjusting. Some of these are beneficial and some are detrimental. They include:

1. Delay: Slowing up that could occur anywhere in the system.

2. Adaption: No longer perceiving the input.

3. Habituation: No longer attending to the stimulus.

4. Filtering (gating): Selectively omitting certain types of information usually according to a priority scheme.

5. Errors of Omission: Failing to process information.

6. Approximation: Neglecting the delicate aspects of the task and faking it.

7. Escape: Leaving the scene or taking other steps that completely cut off the input of information.

8. Alter response variability.

9. Attentional Changes: Altering the spread of attention or site of attention.

10. Change decision criteria.

11. Condensation: Filtering on a cognitive level resulting in information loss.

12. Reorganization: Restructuring on a cognitive level without losing information; e.g., chunking.

13. Blocking: Slowly responding during intermittent periods or committing irregular omissions.

14. Preparation: Using time prior to the event to get ready.

15. Guess: Making one of the responses in the appropriate class at random--this is sloppiest form of approximation.

16. Errors of Commission: Processing information incorrectly and failing to correct for it.

Little can be done about these sixteen human failings in WWMCCS design, but much can be done by conducting training exercises and critiques to reduce the likelihood that such failings will interfere with effective WWMCCS operations.

6.4 WWMCCS Implications

A limited number of comments can be made at this time with respect to some decision-making issues that impact the WWMCCS design.

6.4.1 Training of the NCA and crisis action officers - Perhaps the most obvious and most important of the implications of the foregoing analysis for design of WWMCCS is the necessity of ensuring that the NCA has extensive knowledge of and experience with the system as it actually functions. This experience should be of several kinds. Most important, of course, is experience with the functioning system, so that the NCA knows how it works, what its inputs and outputs are, what errors can be made and at what level, how these errors are detected and corrected, and generally how to interpret unusual system outputs. Almost equally important are exercises in recognizing and coping with these unusual outputs. Participating in what may appear to be unreal war games seems like an unreasonable and excessive demand on the NCA's time, yet how else can the NCA become acquainted with system behavior in catastrophic situations?

The time costs of such activities cannot be avoided. But certain other costs can and should be. Perhaps the most important of these is the cost of explaining such activities to newspapers, political opponents, and the

like. While the existence of WWMCCS and NCA's role in it must and should be matters of public knowledge, the detailed content of any particular scenario need not be; and the fact that the NCA participates in exercises of the system can be as much a matter of routine as other facts having to do with their role.

Training of crisis action officers should emphasize the following:

- Prior to a crisis, pre-canned lists of options should be developed that suggest possible areas for consideration by decision makers in response to a few questions about a specific situation. These lists of options should be developed jointly by the JCS and the appropriate CINCS and used jointly in times of crisis.

- In a crisis, action officers should be made aware of key uncertainties (about outcomes and objectives) and of conflicts, where they exist, among objectives. This will force them to define the problem more carefully and to generate courses of action that address the desired outcomes.

- Procedures for course of action development should make action officers aware of

  a. the differences between a full-scale war and a crisis in terms of the kinds of options one should consider;

  b. the key role of option generation;

c. the impact of objectives and changing situations on option generation--the iterative nature of the process; and

d. a methodology for handling uncertainty and conflicting, multiple objectives.

6.4.2 Video conferencing - All the participants in the CAS workshop agreed that the introduction of video versus audio conferencing would substantially improve the decision process. First, they all agreed that "face-to-face" conferencing would increase the confidence of the NCA in the information being presented. Second, because the decision situation in 1985 will be far more complex than that which exists today, the NCA will require a much more sophisticated communication means than that afforded by the current audio-only systems. A video terminal interfaced with a computer offers the potential for this. To understand why, it is necessary to consider the elements of communication in a broad sense.

Licklider (1968) argues that any communication between people consists of a common experience with information models. Each model is a conceptual structure of abstractions formulated initially in the mind of one of the persons who would communicate. If the concepts in the mind of that person are very different from those in the mind of another, there is no common model and no communication.

By far the most numerous, most sophisticted, and most important models are those which reside in men's minds. However, there are some problems with these internal models; for example, the model has access only to the information stored in one man's head, and therefore can be observed and manipulated only by that person. Society tends to distrust the modeling done by a single mind and demands concensus or

at least majority agreement. In an abstract sense, this amounts to the requirement that individual models be compared and brought into some degree of accord. Thus, the requirement is for communication which we can now define concisely as "cooperative modeling"--cooperation in the construction, maintenance, and use of a model.

When people communicate face-to-face, they externalize their models so that they can be sure they are talking about the same thing. Even such a simple externalized model as a flow diagram or an outline, because it can be seen by all the communicators, serves as a focus for discussion. It changes, very fundamentally, the nature of the communication. Licklider argues that when communicators have no such common framework, they merely make speeches at each other. When they have a manipulable model before them, they "utter a few words, point, sketch, nod, or object."

If the dynamics of communication are model-centered, then a requirement for a communication device, particularly one that must operate in a complex decision-making environment, is that it provide facilities for externalizing the models held by the various conferees. This is important not only to ensure communication with the NCA but also to ensure that the models being invoked to describe the decision-making situation are adequate to deal with that situation.

Simon (1957) suggests that a decision maker will cognitively construct a simplified model of the real situation in order to deal with it. The decision maker's behavior is consistent with respect to this model, even though that behavior is not even approximately optimal with respect to the real world. This principle of bounded rationality suggests that as decision-making tasks become more complex,

people will typically apply additional strategies for processing information; this serves to further reduce cognitive complexity. Examples of this behavior have been observed in the reports of crisis management in a number of real situations. It is typically the case that, out of the hundreds of alternatives which may be available to the decision maker at each decision point, on the average only a few, and never more than a few dozen, are actively considered. And only a few branches of the decision tree are explored deeper than two or three nodes before action is taken. A way to deal with this bounded rationality (which may, as we described above, have the effect of neglecting options or failing to consider in any detail the consequences of a particular option) is to increase the complexity of a decision maker's information processing model by externalizing portions of it.

Although information display variables have been extensively studied, very little attention has been given to the question of how information should be encoded, organized, and sequenced to facilitate decision processes. A number of studies (for example, Herman et al., 1964; and Baker and Goldstein, 1966) indicate that the way information is encoded has important effects on decision performance. Considerably more research is needed, however, to establish guidelines for the design of displays that will aid decision makers. We believe this is particularly crucial in establishing confidence and credibility with the NCA.

6.4.3 Establishing confidence and credibility with the NCA - In a "worst case" situation, a surprise attack against the CONUS, critical NCA decisions are required in a matter of minutes and seconds. If the NCA is not thoroughly knowledgeable and comfortable with the attack assessment system and with WWMCCS generally, the initial reaction will

be to resist the conclusion that an attack is underway and that a decision must be made immediately.

The design requirement for the NCA-WWMCCS interface is the need to enhance NCA confidence in the "military" advice, information, and recommendations the system furnishes. Design considerations should include the following:

- Data bases and displays should not flood the NCA with information. The system should be selective about the synthesized data that is finally presented to the NCA. However, the system should have a capability to retrieve a lower order piece of information, if it is requested. The NCA should understand that the system will provide limited, synthesized data for time-urgent decision making but also has the capability to provide more detailed data if needed. The data and the data bases should have good traceability.

- In a surprise attack situation, the manner in which the data are ordered, sequenced, and displayed is critically important. When low confidence assessments must be presented during the initial NCA contact, the system should also indicate (immediately) what system checks are taking place to confirm or deny the attack indications. Some false alarms, even at the NCA level, should be acceptable. A false alarm might provide vital feedback on the expected "NCA starting gate" reaction times.

- There is a requirement for a system the NCA can spend some time with during peace time without drawing attention to the fact that it is a "war game."

- o Close advisors can be expected to "protect" the NCA from the system (displays). Displays should indicate clearly whenever a senior military official believes the NCA should have direct access to the information. The White House Situation Room could become a time-consuming filter.

- o Information displays at the highest level (NCA, NMCC, SAC, NORAD) during a CONUS attack situation should be identical. Otherwise, confusion and delays will occur.

6.4.4 Probabilities as outputs of WWMCCS - Many hundreds of different actions, denoting different stages of readiness of different offensive and defensive systems, are called for at various stages in a progressively more threatening military situation. The numbers are far too large, and the nature of these actions are far too intricately interrelated, to permit successful decision about each one by NCA. Yet a properly orchestrated response to an unfolding military threat requires exactly that kind of centralized coordination--indeed, that requirement is exactly what WWMCCS is all about. How can this be managed?

The solution is straightforward in principle, though extremely complex in execution. For the class of situations considered herein, the crucial question reduces to: is the U.S. under attack, or not? If so, by whom, and with what purpose? The set of unambiguous answers to these questions is small. Either we are under attack, or we are not. The total set of possibilities is under ten, probably under six.

The obvious solution to orchestrating responses to threatening situations in which the answers to these questions are ambiguous lies in measuring the ambiguity.

The natural metric for the purpose is probability. A list of the six (or ten, or whatever) hypotheses of current interest, and a probability attached to each, would be an extremely attractive output for WWMCCS. Operational techniques looking toward development of such probabilistic command systems have been extensively studied and are now in routine use in certain intelligence system contexts.

The advantage of such probabilistic outputs is that they can easily be substituted for on-the-spot action selection. Altering readiness status, weapons staging, defensive measures, and even weapons release can be made contingent on the passing of certain probability thresholds. Then, if a threshold is passed, the action called for can be routinely begun, unless the NCA orders otherwise. Sophisticated analyses, done at leisure ahead of time, can be used to determine optimal thresholds for each action so controlled.

In no sense does this deprive the NCA of choice or of control. The NCA can exercise control in any or all of three ways. One way is to participate ahead of time in specifying the probability thresholds for various actions. A second way, on-line, is to influence or determine the probabilities assigned to various hypotheses, and thus the actions controlled by those probabilities. A third way, also on-line, is to veto actions considered unwise, even though the probabilities call for them.

6.4.5 Vetoes versus decisions to act - A preceding section of this report discussed the pressures to delay decisions that inevitably fall on the NCA in a rapidly unfolding threat situation. These pressures are all one-sided; they all lead to delays, not to overhasty action.

The use of probabilities as thresholds controlling action would permit a better balance between pressures

in the two directions. One way of accomplishing this, with respect to irretrievable actions that take considerable preparation (such as launching missiles), would be to separate the decision into two parts, having two different probability thresholds. The first, with the lower probability threshold, would be to initiate the process of launch. Built into that decision would be the intention to terminate the process at the last feasible moment before launch. Once started, the preparation process could run without attention, but the NCA should have a continuous display of time-to-go before the last feasible moment of veto. Prior to that last feasible moment, the NCA would have to make a decision either to veto or to order the launch to proceed; failure to act would be taken by the system as equivalent to veto. (This latter provision ensures against lost communications, heart attacks, and similar disasters.)

The procedure is not typically applied to a variety of such processes; the substance of this suggestion is that a relatively highly sophisticated system like WWMCCS could profit from applying exactly the same logic to processes whose time delays are measured in minutes rather than hours. For example, in a situation in which the U.S. receives a nuclear attack without strategic warning, the use of probability thresholds would also permit a considerable refinement of techniques: those thresholds need not remain invariant with time. Some actions have obvious probability threshold patterns: the threshold remains constant over some period of time, and after that time the action becomes meaningless, so the threshold rises to 1 (or to infinity, if uncertainty is measured in odds). Such cases, while numerous and important, are uninteresting; the only problem is to figure out the last possible moment at which the action still makes sense.

More interesting cases arise when the value of the action changes in some continuous way with time. An example is that of counter-force fire as a response to nuclear missile attack. Here, clearly, the earlier the action is taken, the better; the best case of all would be if the counter-force fire could hit before the attack started. What happens to the probability threshold for counter-force fire as a function of time? Somewhat casual analysis indicates that it goes up monotonically. In fact, rather to our surprise, we have been unable to discover any instance in which a probability threshold goes down, even locally, as a function of time. This, if confirmed by more careful analysis, is an important conclusion. It implies that the accumulation of evidence in favor of the hypothesis must increase the probability of that hypothesis at a pace faster than that at which the probability threshold goes up if that action is to occur.

6.4.6 Integration of intelligence information with WWMCCS - We have previously emphasized the delay-causing properties of the very low prior probabilities attached to catastrophic events. We also emphasized that to some degree these delays were entirely appropriate: It should take considerable evidence to overcome a strong prior presumption in the opposite direction.

But, much prior information is available about catastrophic events, and much of it is or can be timely. It is, for the most part, intelligence information.

With respect to any command system, the intelligence system primarily provides prior probabilities. It is important that these be routinely provided, and used. If an explicitly probabilistic version of WWMCCS were to be designed, it seems likely that intelligence specialists, not system operations, should have the responsiblity for setting

and periodically updating the system's prior probabilities. This would have two advantages. It would prevent the prolonged continuation of one state of the world from making it impossible to recognize that things have changed, and it would permit effective and close integration of intelligence system information into daily WWMCCS operation.

6.5 Decision Templates

Based upon the research findings described in this and the previous chapter and our experience with the templates as described in the previous chapters of this report, we are convinced that decision templating methodology provides the means to meet DCA's goal of improving the communication of information and the quality of national security decision making in crisis action situations.

APPENDIX A

ADP SUPPORT REQUIREMENTS EVALUATION

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ADP SUPPORT REQUIREMENTS EVALUATION

THE APPROACH

The approach underlying the analysis of ADP support requirements involves the following steps:

1. Define the most likely and most important contingency action situations expected to occur in the PACOM area.

2. Identify the information concerning friendly and foreign forces that would be needed by the PAC battle staff during the planning and action phases of the contingency situations.

3. Describe how new and improved automated data support systems would assist the battle staff during the crises management process.

4. Assess and calculate the value of candidate ADP support systems given estimated probabilities that the different situations occur in the PACOM area.

THE SITUATIONS

The situations depilted in Figure A-1 and described below are considered most likely to occur in the PACOM area; they are oriented to geographic areas and listed in accordance with their importance and potential for involving U.S. forces. Even when the potential for direct involvement of U.S. forces is considered low, PACOM will find it necessary

to monitor developments inasmuch as the Command may be required to provide some form of U.S. assistance. The subset of scenarios for each situation is are listed in order of likelihood of occurrence.

A. <u>The Korean Situation</u>

1. Large-scale North Korean guerilla force attack of sufficient size to provoke a significant ROK response.

2. A North Korean military attack into the Republic of Korea designed to exploit a political upheaval or a highly unstable ROK government as perceived by North Korean leadership.

3. An incident in or along North Korean territory involving the loss of a U.S. Intelligence collection platform.

4. A major North Korean air penetration of the Republic of Korea designed to neutralize key ROK installations and forces.

B. <u>The Indo-China Situation</u>

1. A large-scale incursion into Laos by Vietnamese military forces.

2. Extensive fighting in northern Cambodia and eastern Thailand between regular Thai forces and Vietnamese regulars or Vietnamese controlled insurgency forces.

3. A large-scale PRC military attack into Vietnam of sufficient size to provoke some form of Soviet counteraction.

C. <u>The Taiwan Situation</u>

1. Limited military action by PRC forces against the offshore islands of Formosa.

2. A dramatic PRC show of force (involving air and naval units) designed to exercise limited political control of Formosa.

3. A major air/sea attack against the Taiwanese political structure and control centers which may or may not be followed by a full-scale attack and the outbreak of general war.

D. <u>The Japanese Situation</u>

1. Soviet violation of Japanese air space leading to an intercept and shootdown of a Soviet aircraft.

2. A Soviet-Japanese confrontation (involving the use of limited military force) over the ownership of the Kuril Islands.

3. A "show of force" exercise by Soviet Naval combatants leading to a limited Naval engagement with Japanese forces in adjacent Japanese waters.

E. <u>The Philippine Situation</u>

Military action by dissident forces leading to a governmental request for U.S. assistance.

F. <u>Situations Directly Involving U.S. Forces</u>

1. A peripheral reconnaissance aircraft interception and shootdown incident.

2. An incident resulting from Soviet surveillance and harassment of a U.S. Naval Task Force.

INFORMATION

The information concerning foreign and friendly forces that would be required by the battle staff is listed below. The degree of specificity would vary depending upon the situation and the extent of U.S. involvement.

A. Information to perform initial situation assessments

1. To the extent available, information concerning stated or official U.S. objectives with respect to the area and situation.

2. Information and assessments concerning the implications of the situation for the U.S.

3. Historical information to include economic, political, military and psycho-social factors bearing on, and leading to, the current situation.

B. Information concerning the deployment of friendly and adversary forces

1. Units involved and in reserve--their organization, designations, composition, type weapons, commanders, readiness status, and combat capability.

2. Units support--availability of nuclear and conventional munitions, delivery forces, sortie levels, operations rates, fuel stocks, guided weapons, depot support, reserve supplies.

C. Information concerning the employment of friendly and adversary forces

1. Reaction times--estimated time and distances to forward bases and engagement areas by incremental levels of forces.

2. Environmental impact factors--suitability of terrain for mechanized forces, natural obstacles, road networks, and rivers.

D. Information concerning the C^3I capabilities of foreign forces

1. Foreign C^3 doctrine and organization--extent to which command and control of forces is centralized. Vulnerability of the C^3 organization to degradation, neutralization and deception.

2. Redundancy and reliability of the foreign nations' C^3 equipment, deployments, and operations.

3. Responsiveness of the C^3 systems with respect to decision channels and approval/execution times.

4. Intelligence capabilities in terms of reliability, timeliness, resources, and vulnerabilities.

E. Information concerning the vulnerabilities of friendly and adversary forces

1. Vulnerability to neutralization by nuclear and conventional air and surface force attack.

2. Vulnerability to electronic countermeasures and deception tactics.

ADP SUPPORT

Requirements for ADP support of such functions as information storage and retrieval, data display, and contingency planning and decision making are described below. Along with each requirement, two response times are estimated: one for a completely manual C^3I system, which is arbitrarily given a value of zero, and one for what decision makers and battle staff personnel would like to have, which is given a value of 100.

A. Initial Assessments

HISTORICAL SUMMARIES

- o Call up and display historical and background information that bears on, and would lead to a better understanding of, the currently developing situation.
- o This requires a capability to display summaries of past and recent antagonisms, animosities, border disputes, confrontations, and conflicts concerning the involved countries. Information concerning treaties and alliances with other countries is of value.
- o Response times are:
  6 hours = 0
  1 hour = 100

OFFICIAL STATEMENTS

- o Call up and display current summaries (to include pertinent quotations) of official statements,

announcements, threats made by foreign leaders of involved countries.

- o Response times are:
  6 hours = 0
  .5 hour = 100

POLITICAL IMPLICATIONS

- o Define the current situation to include the major issues, the implications for the U.S., and the political situations existing within the involved countries. This should include:

  - the key leaders, their views and the government;

  - the opposition leaders and their views.

- o Response times are:
  6 hours = 0
  1 hour = 100

THIRD-WORLD NATIONS

- o Call up and display current views and actions taken by third-world nations, the super powers, and/or the U.N. Specific reactions of interest include:

  - expressions of political propaganda and economic support;

  - U.N. initiatives, proposals, and reactions;

  - direct military support in the form of personnel, equipment, or technical assistance;

- provision of mercenary forces;

- willingness to risk direct military involvement.

o Response times are:
  4 to 8 hours = 0
  .5 to 1 hour = 100

B. Operational Situation

LOCATION OF FORCES

o Call up and display maps of the area and locate engaged military forces to include forces in reserve. This set of files should include the capability to call up and display a historical presentation of the ebb and flow of the confrontation.

o Response times are:
  8 hours = 0
  .7 hour = 100

COMPOSITION OF FORCES

o Prepare and display an assessment of the forces of the involved countries:

  - display composition of ground forces to include photography and performance characteristics of major weapons systems;

  - information should include units, strengths, and organization, as well as qualitative assessments concerning combat readiness, training, and experience;

- present Air Forces (as above);

- present Naval Forces (as above);

- included in the above are: armor, artillery, infantry, fighters, bombers, air lift, RECCE forces, air defense, radars, SAMs, surface and sub-surface combatants, air capable ships, amphibious forces, and land-based reconnaissance.

o Response times are:

  2 hours = 0

  .3 hour = 100

LOGISTICS STRUCTURE

o Call up and display information concerning the logistics structure for the involved nations and their forces. The information should include:

- depots (forward and rear) available to support deployed forces and provide such supplies as fuel, munitions, spares and general support items of food, clothing, and specialized technical assistance;

- airfields available in the combat zone for large-volume logistical movements;

- rail heads for combat zone supply support;

- parts available for military usage;

- coastal areas suitable as expeditionary ports and across the beach off-loadings;

- railroad networds and major marshalling yards (information on the volume that can be handled by each);

- major ports and their capacity for handling large combat and transport vessels;

- rear area airfields and their capacity for handling large supply movements.

o Response times are:
  12 to 24 hours = 0
  6 hours = 100

C. Employment of Military Forces

ENVIRONMENTAL FACTORS

o Prepare and display information concerning environmental factors. This includes information displayed in graphic and narrative form describing:

- unique terrain features such as rivers, roads, and obstacles to armor;

- climatological studies and weather information that could impact on air and ground operations;

- sea state data that could affect naval operations.

o Response times are:
  For terrain features--
    6 hours = 0
    1 hour = 100

For weather and sea state information--

1 hour = 0

.2 hour = 100

DOCTRINE AND TACTICS

- Call up and display information concerning doctrine and commanders of involved forces. This should include photos and biographical data to include commanders' views on doctrine, armored tactics employment of air forces, and nuclear warfare. Psychological profiles which may reveal exploitable weaknesses are required.

- Response times are:

  2 hours = 0

  1 hour = 100

NUCLEAR CAPABILITIES

- Call-up and display information concerning the capabilities of foreign forces to conduct nuclear operations. This information should include:

  - nuclear-capable units and equipment for conducting offensive and defensive air and surface operations;

  - nuclear weapons assembly, storage, and maintenance procedures and facilities;

  - chemical warfare information (as described above for nuclear).

- Response times are:

  4 hours = 0

  .3 hour = 100

MOVEMENT CONSTRAINTS

- Call up and display information concerning the movement times of involved forces. Information is required on the time and distance to:

  - forward areas and

    airfields for combat operations;

    airfields to discharge replacements and support;

    assembly points for major ground, combat forces;

  - engagement areas and

    line of combat for ground forces;

    area of air-to-air combat operations;

    area of expected Naval contact;

  - deploy reserves and

    times for incremental build-up of ground-to-ground and ground-to-air combat units;

    movement times (by percent of force) by air to forward areas;

    movement times (by percent of force) by sea to forward bases.

- o Response times are:

  3 hours = 0

  .4 hour = 100

D. <u>Command, Control, Communications, and Intelligence</u>

C^3 OPERATIONS

- o Prepare and display a schematic of the C^3I system for the air, ground, naval, and joint forces of the countries involved.

- o Analyze doctrine to determine extent to which command and control of forces is centralized;

  - display how nuclear, chemical, and conventional targets are nominated, delivery forces selected, weapons controlled, forces executed, and damage assessed;

  - analyze offense/defense strategies, how forces are massed, replacements employed, and fire power planned;

  - analyze the relationship of forces--air, ground, naval--determination of priorities and the use of maneuver and exploitation tactics.

- o Response times are:

  24 hours = 0

  2 hours = 100

C^3I WEAKNESSES

- o Call up and display the C^3I modes of foreign forces and associated equipments for all levels of command as required for signature analysis, redundancy evaluations, mobility assessments, and weaponeering studies.

- o Perform essential vulnerability analysis of the C^3I systems to deception, ECM, and direct attack.

- o Response times are:

  8 hours = 0
  1 hour = 100

SURVEILLANCE CAPABILITIES

- o Maintain and display information concerning the surveillance systems and capabilities of the nations involved in the situation. Displays should include the technical performance capabilities and the operational characteristics of all air, space, land, and sea-based surveillance systems.

- o Response times are:

  6 hours = 0
  2 hours = 100

E. <u>Net Assessments</u>

NET CAPABILITIES

- o Call up and display net assessments of the capability of the involved countries' forces to:

  - gain and maintain control of the air;

- interdict the main lines of air, land, and sea communications and isolate opposing forces in the combat area;

- provide close air support to surface areas;

- conduct reconnaissance of the air, ground, and sea zones of combat;

- provide air defense for the security of the communications zone and sea lines of communications;

- provide air and sea lift for the movement of high-priority logistics, replacement personnel, and units;

- project fighting forces ashore;

- rapidly deploy large armored formations and coordinate multi-division ground force operations under adverse conditions of weather and enemy pressure.

o Response times are:
  12 hours = 0
  2 hours = 100

EXPLOITABLE VULNERABILITIES

o **Display and compute the vulnerabilities of targets and objectives associated with the involved forces to ECM, deception, and direct attack. Specifically, information will be needed on the vulnerability of air forces to include:**

- vulnerability of aircraft in air combat and basing mode;

- vulnerability of GCI (airborne and ground-based) capability;

- vulnerability of air forces support structure (POL, depots, munitions, personnel);

- vulnerability of aircraft, air control, and air defense systems to ECM;

- vulnerability of air C^2/defense systems to deception.

o Vulnerability of ground forces to include:

  - vulnerability of mechanized forces to ground attack and ground-based anti-armor systems;

  - vulnerability of mechanized forces to long-range surface-to-surface missiles;

  - vulnerability of the forward, ground-based air defense system to ground-based attack;

  - vulnerability of organic aviation;

  - vulnerability of ground forces to ECM and deception.

o The vulnerability of naval forces to include:

  - vulnerability of major units (carriers, cruisers) to naval attack;

- vulnerability of screening forces to naval attack;

- vulnerability of fleet air defense forces;

- vulnerability of undersea forces to naval attack;

- vulnerability of major forward staging/support bases;

- vulnerability of replenishment forces;

- vulnerability of naval forces to ECM and deception.

o Response times are:

  8 hours = 0

  2 hours = 100

ADP SUPPORT REQUIREMENTS

Initial Assessments	Operational Situation	Employment Factors	C^3I Capabilities	Net Assessments
Historical Summaries	Location of Forces	Environmental Factors	C^3 Operations	Net Capabilities
Official Statements	Composition of Forces	Doctrine and Tactics	C^3I Vulnerabilities	Exploitable Vulnerabilities
Political Implications	Logistics Structure	Nuclear Capabilities	Surveillance	
Third-World Nations		Movement Constraints		

Figure A-1

SITUATIONS REQUIRING PACOM ADP SUPPORT

APPENDIX B

SEMINAR SCENARIO AND QUESTIONS
TO BE ADDRESSED DURING THE WORKSHOP

APPENDIX B

SEMINAR SCENARIO

(This is an extremely low-probability scenario prepared as exercise material for the CAS symposium. Its sole purpose is to provide a framework for discussing crisis action ADP support requirements.)

Background Information

The Soviet Union, through its highest level heads of state channels, has advised the U.S., Japanese, and South Korean governments that the North Koreans have in their possession at least three and possibly five Soviet nuclear weapons. According to the much embarrassed Soviet leadership, these weapons were stolen by a North Korean raiding party from a Soviet FROG missile unit during an exercise being conducted along China's northern border. The theft occurred approximately twenty-four hours ago.

The Japanese have a highly placed, completely reliable source who is in contact with the North Korean leadership, and he reports that three weapons arrived by helicopter a few hours ago (at 0730L on 16 July) at a North Korean light bomber base located four miles from Wonsan, a city on the east coast. It should be noted that Japanese-North Korean relations have deteriorated during the past three months, reaching a new low a few days ago when the North Koreans detained the Japanese Ambassador for approximately eighteen hours at the Pyongyang Airport. The Japanese, therefore, believe the weapons will be used against their country and have appealed to the U.S. for assistance.

The South Koreans have confirmed through photography (and other means) the arrival of a helicopter with the Soviet weapons at the airfield near Wonsan. The South Korean leadership believes the weapons are intended for use against South Korea and have stressed the need to react immediately. They have also concluded that the North Koreans plan to use the weapons immediately; otherwise, it is reasoned, the North Koreans would have taken more elaborate precautions to conceal the location of the weapons.

You are a member of the CINCPAC battle staff when the first JCS action message is received. The message provides additional information and indicates that a number of different courses of action have been under consideration. The message indicates that the North Koreans have, during the past two weeks, been engaged in bomber training exercises. The training mission profiles, although confined to North Korea and adjacent waters, matched (in time and distance) strikes against the central Honshū area of Japan. It is believed the North Koreans could act quickly with little or no additional training, if they chose to do so, and the Soviets have stated the weapons can easily be converted to gravity bombs.

The JCS message discussed in general terms several of the action options which have been under consideration, some of the uncertainty surrounding the situation, and certain of the Washington concerns. For example, one action option that had been considered was to support a large-scale ROK operation into North Korea to seize the weapons. Another was to provide U.S. sea- and land-based anti-air radars, aircraft, guns, and missiles to form a concentrated defense of Japan against a light bomber attack. Another was to organize a joint U.S.-Japanese task force equipped with air mobile assault teams capable of quickly neutralizing the weapons and the delivery vehicles. Another was to maintain

continuous armed air surveillance of the Wonsan airfield. The uncertainty concerned the possibility of two more stolen weapons which, according to unconfirmed reports, might be located at another North Korean airfield. A major concern expressed by Washington was whether the Soviets would attempt to recover the weapons themselves or perhaps try to interfere with a U.S. recovery effort.

Course of Action Development

The essential part of the JCS message reads as follows:

"The JCS directs CINCPAC to prepare, deploy, and insert U.S. and ROK military forces, with supporting Japanese forces, into the Wonsan area for the purpose of recovering the three Soviet nuclear weapons at Wonsan airfield and destroying the IL-28 light bombers at the airfield.

The invasion force will be of such size and composition to accomplish the entire mission in two days. The force is scheduled to penetrate the 12-mile limit in the vicinity of Wonsan at 2030Z on 20 July 1979 and to complete the withdrawal 48 hours later. (This JCS message is received in CINCPAC command post 0939/17 July 1979.)

There is one (1) mechanized infantry division in the general Wonsan area. One well-equipped regiment of the division could close on the airfield in approximately 12 hours. The other two regiments could close (unopposed) in 36 to 48 hours. Armor assigned to the division includes 60 T-54/55 tanks and 35 PT-76 tanks. The organic and available artillery includes self-propelled guns up to 152 mm plus rocket launchers. No FROG SSMs are estimated in the vicinity. Four W-Class

submarines operate in the area plus ten KOMARS and 22 smaller torpedo boats. There are two SA-2 (SAM) battalions in the vicinity of the airfield plus AAA air defense positions. Air order of battle at Wonsan consists of 21 IL-28, 12 SU-7, 18 MIG-17, 6 MIG-19 aircraft. Numerous other airfields and potentially effective aircraft in vicinity. [Note for seminar personnel: Use your collective judgment concerning the U.S., ROK, and Japanese military forces (assets) currently available in the PACOM area.] Regarding command arrangements, the three governments have agreed to the following: the Combined Forces Commander will be U.S., and the President has designated the CG, 8th Army, to serve in this position; the deputy commander will be ROK; and the deputy for Naval support will be Japanese.

Need soonest your detailed plan for approval by JCS and highest authorities."

(Note for seminar personnel: The process you go through as a battle staff is of primary interest to the symposium. Specifically, how do you determine the availability and readiness of U.S., ROK, and Japanese forces? How do you designate and alert units, identify transportation needs and assets, coordinate loading and deployment schedules, collect intelligence information?)

Execution Planning

During the "execution planning" phase--which, because of the time-urgent situation, must be carried out almost simultaneously with "action development"--CINCPAC identifies the timing, basing, and logistic requirements to be met by the components, the Services, and other Unified and Specified Commands and the supporting commands and agencies. The commands and agencies respond by identifying and notifying

actual units and their mode of deployment. [Note for seminar personnel: It is re-emphasized that the symposium is primarily interested in the process by which you accomplish this.]

Assume that just 36 hours before the force is directed to penetrate the 12-mile zone, the following JCS message is received.

> "CINCPAC is directed to include in the invasion force a group of 38 Soviet military personnel consisting of nuclear weapons technicians, weapons custodial personnel, and an interpreter. These personnel will be picked up (at a designated airport in the vicinity of Vladivostok) by a CINCPAC aircraft ASAP and integrated into the U.S. group of weapons experts scheduled to deploy with the recovery force."

Execution

CINCPAC monitors the final phases of the deployment and awaits the JCS execution order. Eighteen hours before penetration hour, the following JCS message is received at CINCPAC:

> "Sensitive Intelligence sources have revealed the location of two more Soviet weapons at another airfield in the vicinity of Wonsan. The airfield, designated SINWU on WAC chart 674, is six miles north of the airfield where the three weapons are located and five miles from Wonsan. The estimate of the general enemy situation remains the same. Modify your recovery plan to include the second airfield, the two additional weapons and the IL-28 aircraft located on SINWU airfield." [Note for seminar personnel: Discuss the process by which you implement this modification.]

QUESTIONS TO BE ADDRESSED DURING THE WORKSHOP

COURSE OF ACTION DEVELOPMENT SESSION

1. There are a number of data bases available to you for deployment planning. Given a time-urgent situation such as the one described in this scenario, would you find the data bases accurate? Easy to access? Contain the needed information?

2. This scenario makes it necessary to disseminate large amounts of information to different headquarters in a timely manner. Examples are planning information to the ROK and Japanese, current photography and graphic materials of the Wonsan airfields, and environs to the components. Is it easy to send and is it received on time?

3. You are familiar with the kinds of contingency planning that takes place in the U&S commands. Given this particular scenario, would you expect to find applicable crises or contingency plans available to you? Would you expect the plans to contain real units which you would then use in your actual "Wonsan" plan?

4. With regard to (3) above, does the seminar have any thoughts on how much pre-planning can and should be done at the U&S and component command level? Some have said its impossible to pre-plan for crises situations because all situations are so different. The best approach is to wait until it happens and then "ad hoc" your way through it. Others contend that the more pre-planning, the better. Although the plans you have prepared beforehand will not fit the situation exactly,

they will be very useful. Your views would be appreciated.

5. Should crises plans and planning data be stored, accessed, and displayed using ADP techniques? If you believe they should, how would it help?

Execution Planning

1. Combining units, platforms, log support, schedules, and basing into a final operation order given the time-urgency of this scenario is an extremely complex task. Can you describe elements of the combining process where ADP support could help?

2. There is a flow plan in the form of a handout; it is entitled "Crisis Action System - Phase V - Execution Planning." Could this, or a chart similar to it, serve as a checklist for the battle staff? Perhaps it could provide the basis for a computer program to handle the operation order problem described in (1) above.

Execution

1. The preparation of frag orders should be a fairly simple operation compared to the other tasks. Do you agree?

APPENDIX C

REFERENCES

APPENDIX C

REFERENCES

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